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SOME NEW METHODS AND APPARATUS FOR TESTING THE ACUITY OF HEARING AND THEIR RELATION TO THE SPEECH AND TUNING FORK METHODS.*

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There may be some otologists who believe there is not much to be gained by making tests of the acuity of hearing. They see in such measurements little value for clinical purposes, but since a considerable portion of the program for this session has been devoted to this subject I shall assume that the majority of those present believe that some sort of acuity tests is not only worthwhile but very important.

The kinds of hearing tests that are needed may be classified into four groups according to their purpose as follows:

1. *Industrial* or those made for determining the fitness of a candidate for employment. In certain types of work it is particularly important that a prospective employee meet a definite requirement for acuity of hearing. Tests made in the army and navy for various branches of service are conspicuous examples of this kind of test.

2. *Educational* or those made for determining the degree of hearing of school children both in the public schools and in the schools for the deaf for the special purpose of determining the proper methods to be used in their education.

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From the Bell Telephone Laboratories, Inc.

3. *Clinical* or those made for assisting the doctor to make a proper diagnosis of the cause of deafness.

4. *Research* or those made to determine new facts about both normal and abnormal hearing.

It is evident that different methods are appropriate for these different purposes. Unless the particular purpose is kept in mind there is apt to be confusion when discussing the merits of a method of testing hearing.

It is highly desirable that a single scale be used for representing the degree of hearing which is independent of the method used, and which has a general application to all the purposes mentioned above. Therefore, before describing the apparatus developed for making hearing tests for these various purposes, I desire to describe the scale of hearing which is now being used by a number of otologists, which may be used for all these purposes, and show how the results obtained from the commonly made voice test, watch tick, acoumeter, coin click, and tuning fork tests can be expressed in hearing loss units on this scale.

NEW SCALE FOR MEASURING THE ACUITY OF HEARING.

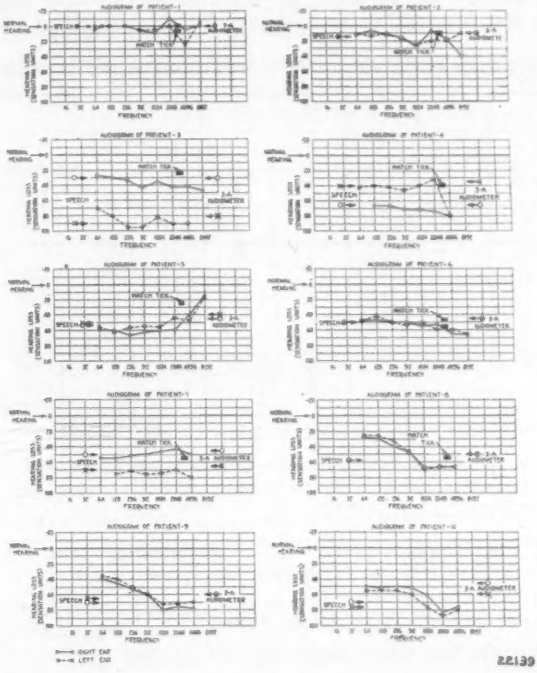
This scale for measuring hearing has been described in a paper given before the Franklin Institute (Physical Measurements of Audition, September, 1923). It is the one indicated on all the audiometers made by the Western Electric Company. It is important to notice, however, that the use of this scale is in no way dependent upon the use of audiometers of this kind. A change in the intensity in the ratio of 10 to 1 corresponds to an increase of 10 units on this scale—no matter what the initial intensity may be. For example, if the initial intensity is 1, then for an increase of 10 units the intensity becomes 10. For another increase of 10 units or a total of 20 the intensity becomes 100. For still another increase of 10 or a total of 30 units the intensity becomes 1000. It is a psychological fact that the sensation increase produced when the intensity changes from 100 to 1000 is the same as when it changes from 1 to 10. It is for this reason that the proposed units are called Sensation units.

One of these sensation units corresponds to a fractional change in the intensity which is approximately the smallest that the average ear can detect. These same units are used in telephone engineering and when so used are called transmission units. They are used to describe the change in loudness of the sound issuing from the telephone receiver due to any changes in the transmission circuit.

The hearing loss H.L. in sensation units is defined mathematically by the equation

$$\text{H.L.} = 10 \log \frac{I}{I_0}$$

where I and I_0 are the intensities which the sound must have to be just audible to the person being tested and to a person of normal hearing respectively. In other words it is the number of sensation units below the normal hearing intensity.

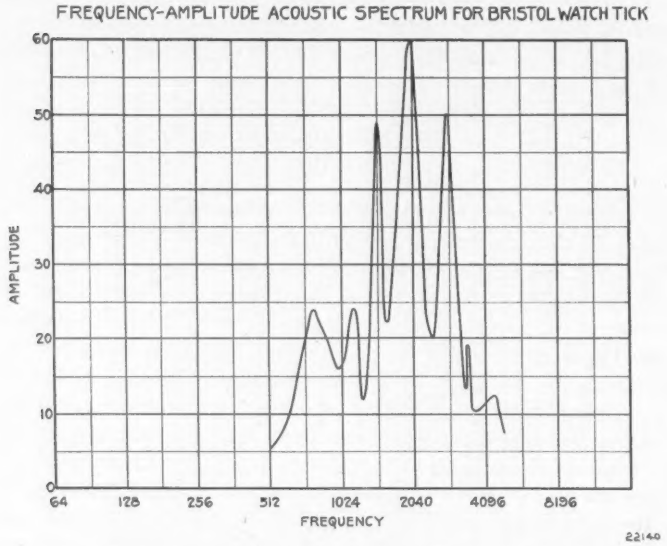


In a paper presented before the American Triological Society by Fowler and Wegel (Audiometric Methods and Their Applications, May, 1922) a hearing scale was proposed which has been objected to by some otologists because it is dependent upon the threshold of feeling as well as the threshold of hearing. On this scale the per cent hearing loss is the hearing loss in sensation units divided by the number of sensation units between the threshold of hearing and the threshold of feeling for an average normal ear. It is un-

doubtedly the best answer to the practical question as to what is the per cent hearing loss, and is very useful in expressing general results. It is particularly useful for describing to the patient his degree of hearing. However, for most other purposes it seems desirable to express results in terms of sensation units rather than per cent hearing loss.

CONVERSION OF HEARING LOSS IN SENSATION UNITS TO PER CENT HEARING LOSS.

The hearing loss expressed in sensation units can be converted into per cent hearing loss by multiplying the former by a factor K



which varies with the type of sound used in the test. It is obvious from the definition given above that this factor is equal to 100 divided by the number of sensation units between the normal threshold of hearing and the normal threshold of feeling for the particular sound used. Experiments made in the Bell Telephone Laboratories have indicated that for speech this factor is .83; for the test tone of the 3-A audiometer it is equal to 1.0; for a watch tick, coin click, or acoumeter it is approximately 1.5. For pure tones the value of K is dependent upon the pitch and is given in Table I. The question marks indicate that the value of K for tones having either 32, 48 or 12,800 vibrations per second are not accurately determined.

RELATIONS BETWEEN SENSATION UNITS HEARING LOSS AND THE MAXIMUM HEARING DISTANCES FOR SPEECH.

Let us now consider the relation between the hearing loss expressed in these sensation units and that expressed in the usual voice test method. If the room in which such tests are made is acoustically treated so that no sounds are reflected from the wall, ceiling, or floor, then the intensity of the sound decreases as the inverse square of the distance. In a room with numerous drapings and a heavy carpet this condition is approximately fulfilled. Tests in our laboratory have indicated that for an average speaker calling numbers with an intensity corresponding to the musical notation MF (mezzoforte) into a normal ear at a distance of 1½ inches

TABLE I.

FACTORS FOR CONVERTING HEARING LOSS EXPRESSED IN SENSATION UNITS INTO PER CENT HEARING LOSS.

Vibration Frequency	K	Vibration Frequency	K
32	3.3 (?)	800	.77
48	2.2 (?)	1024	.76
64	1.5	1600	.77
100	1.28	2048	.77
128	1.09	3200	.81
200	.96	4096	.86
256	.91	6400	.94
400	.83	8192	1.22
512	.79	12800	1.42 (?)

the intensity is 90 SU (Sensation Units) above the normal threshold of audibility. Also, these tests have shown that this intensity is 80 SU above the intensity necessary for a 50 per cent correct interpretation of called numbers. For a voice corresponding to PP (pianissimo) the sensation level is about 15 SU lower and for a voice corresponding to FF (fortissimo) about 15 SU higher. About the same results are obtained when using either a PP voice or a loud whisper. An average whisper is about 15 SU lower than a loud whisper.

Using these data, the inverse square law, and the definition of hearing loss given above it is possible to calculate for each intensity of calling the maximum distance for hearing and interpreting called numbers by a person of known hearing loss. The necessary equations for doing this are developed in Appendix A. In this appendix it is also shown that the maximum distance which the normal ear can interpret called numbers is 40 feet for the average whisper, 222 feet for the loud whisper or PP voice, 1250 feet for the MF voice, and 1⅓ miles for the FF voice. At first thought these num-

bers seem to be unreasonably large to conform with our every day experience, but it must be remembered that we are usually immersed in a continuous noise. This is especially true in the large cities. One needs only to recall the common experience while in the country on an early morning of hearing the cock crow and other familiar sounds at a distant farmhouse to realize that the voice will reach these long distances in a very quiet place.

In the usual office in the city the noise is sufficient to shift the threshold of hearing 20 or 30 sensation units without causing any annoyance. The hearing distances corresponding to the four intensities of the voice which would be obtained in such an office might be as small as 15 inches, 7 feet, 40 feet, and 222 feet instead of the larger distances given above. Therefore, it is seen that a speech test made in such an office would not differentiate between ears that are normal and those having a 30 SU loss in hearing.

The maximum distances which persons having different amounts of hearing loss can interpret these four intensities of voice were similarly calculated and are given in Table II.

TABLE II.

MAXIMUM DISTANCES IN A QUIET PLACE FREE FROM REFLECTIONS FOR INTERPRETING SPEECH BY PERSONS HAVING VARIOUS AMOUNTS OF HEARING LOSS.

Hearing Loss Sensation Units	Average Whisper	Loud Whisper or PP Voice	MF Voice	FF Voice
0	39.5 Ft.	222 Ft.	1250 Ft.	1 1/3 Mi.
5	22.2 "	125 "	704 "	3950 Ft.
10	12.5 "	70 "	395 "	2220 "
15	7.0 "	39.5 "	222 "	1250 "
20	4.0 "	22.2 "	125 "	704 "
25	2.2 "	12.5 "	70 "	395 "
30	15 In.	7.0 "	39.5 "	222 "
35	8.5 "	4.0 "	22.2 "	125 "
40	4.7 "	2.2 "	12.5 "	70 "
45	2.7 "	15 In.	7.0 "	39.5 "
50	1.5 "	8.5 "	4.0 "	22.2 "
55	.8 "	4.7 "	2.2 "	12.5 "
60		2.7 "	15 In.	7.0 "
65		1.5 "	8.5 "	4.0 "
70		0.8 "	4.7 "	2.2 "
75			2.7 "	15 In.
80			1.5 "	8.5 "
85			0.8 "	4.7 "
90				2.7 "
95				1.5 "
100				0.8 "
110		May be reached by speaking tube		
115				
120		Totally Deaf		

It is generally recognized that it is almost impossible to obtain accurate results by means of the usual speech methods because of

the uncertainties of controlling the intensity of the voice, and the noise and acoustic conditions of the testing room. However, for rough work these tests are useful and this table should aid in the interpretation of the results obtained from such tests. It is evident that there are two ways of varying the intensity of the speech sounds arriving at the ear of the patient, namely, by varying the intensity of calling and using a fixed distance or by varying the distance and using a constant intensity of calling. When the first method is used it is seen from Table II that if the tester calls at a distance of 15 inches and the patient cannot interpret an average whisper his hearing loss is greater than 30 SU; if he cannot interpret a loud whisper or PP voice, it is greater than 45 SU; if he cannot interpret a MF voice, it is greater than 60 SU; and finally, if he cannot interpret a FF voice (shouting intensity), it is greater than 75 SU. It is thus seen that a rough measurement of the hearing loss in sensation units is obtained by simply varying the intensity of calling at a given distance.

Probably more accurate results can be obtained by varying the distance using a constant intensity of voice. For distances smaller than 6 inches the results will be unreliable due to the uncertain reflections between the head of the listener and the head of the speaker and the difficulty of making accurate measurements of the distance. This limits the maximum loss of hearing that can be measured by this method. The noise conditions and extreme distances limit the minimum loss that can be measured. For an average whisper this practical range is from a hearing loss of 40 to 20; for the loud whisper or PP voice from 55 to 20; for the MF voice from 70 to 30; for the FF from 85 to 45; the noise conditions limiting the lower value in the first two cases and the size of the room in the last two. When a greater accuracy than 10 or 15 SU is desired it is necessary to calibrate the voice rather than rely upon the tester's judgment as to which intensity of voice he is using. This is done by determining the normal hearing distance or its equivalent for the particular intensity used. A method of doing this is given in Appendix C where it is shown that the hearing loss can be obtained by subtracting two values Y_n and Y obtained from a curve corresponding to the hearing distance for the normal ear and the ear of the patient respectively. Since the normal hearing distances are so large indirect means must be used in their determination except for intensities smaller than the average whisper. By combining both methods a fairly large range of hearing can be covered. It depends, however, upon the ability of the tester to

change accurately the intensity of calling from one type to the other, an accomplishment that is seldom realized.

When this method is used by a tester who is somewhat over-anxious that the patient show an improvement in hearing it might give quite erroneous results. If he should use the PP voice and find the hearing distance one foot before treatment, and then in the test after treatment, in his anxiety, raise the intensity of his voice to that corresponding to MF, he would find the hearing distance had increased to five feet even though there was no change in the patient's ability to hear. The increase from 1 to 5 feet would sound like a big improvement to the patient.

As shown in Appendix B for the same patient *an improvement in hearing of one foot for an average whisper is the same as an improvement of 5½ feet for the PP voice, 32 feet for the MF voice, and 178 feet for the FF voice.* Equation 1 of Appendix B shows that if the hearing distance is expressed as a fraction of the normal distance this fraction will be the same for all intensities of voice used. This shows that the common practice of giving results of voice tests as fractions of the normal distance has a logical basis. As will be seen later there is no such logical reason for expressing the results of tuning fork tests as fractions of the normal time. As indicated in Table II the intensity range of hearing is 120 SU corresponding to a distance variation of one million to one. The range from 0 to 60 SU loss or 50 per cent loss for speech corresponds to a distance variation of one thousand to one. This emphasizes the fact that variation of distance alone is entirely inadequate to cover the complete intensity range for hearing.

REDUCTION OF WATCH TICK, ACOUMETER, AND COIN CLICK TESTS TO SENSATION UNITS HEARING LOSS.

The results of watch tick tests can be reduced by the method outlined in Appendix C. In this case, however, reflections from objects in the room, especially from the head of the patient produce very marked irregularities. This is due to the fact that the components of sound from the watch are mostly in the high frequency region around 2000 vibrations per second. At such high frequencies more definite reflection patterns are produced by the objects in the room than for the low frequencies. The dotted curve in Fig. 1 of Appendix C shows a reduction curve which was determined experimentally for a watch tick and illustrates very well the irregularities which commonly exist in a room even when well damped. The solid curve is based on the inverse square law. In Fig. 2 is shown the relative amplitudes of the component frequencies in a

watch tick sound. From this it will be seen that the watch tick is essentially a test of acuity for frequencies in the neighborhood of 2000 vibrations per second. The loudness of several types of watches when held in contact with the ear was determined to be in a range from 40 SU to 70 SU above the threshold of audibility. An average for good grade watches is 45 sensation units. This means that a patient who can just hear such a watch tick has a 45 SU hearing loss for frequencies near 2000 vibrations per second.

The results of acoumeter or coin click tests can be reduced in the same way. They are open to the same objections as mentioned for the watch tick. This test is also essentially a test for high frequencies.

REDUCTION OF RESULTS OF TUNING FORK TESTS TO SENSATION UNITS HEARING LOSS.

In the standard method for determining the acuity of hearing at different pitches use has been made of a series of tuning forks having various vibration rates through the audible range. The fork is given a standard blow of some sort to set it into vibration. It is then held as close to the ear as possible, preferably with the flat part of the prong directly facing the auditory meatus. The time t in seconds from the striking of the blow until the patient no longer hears the sound is observed. A comparison of this time to that t_0 required for normal hearing gives a measure of the hearing by air conduction. It is shown in Appendix D that the hearing loss H.L. in sensation units is given by

$$\text{H.L.} = \triangle (t_0 - t)$$

where $\triangle$ is a constant of the fork depending upon the amount of damping. In other words the hearing loss in sensation units is obtained by multiplying the decrease in time for air conduction by a constant of the fork. If it is desired to reduce the results to per cent hearing loss the following relation is used

$$\text{Per Cent Hearing Loss} = K \triangle (t_0 - t)$$

the factor $K\triangle$ having a definite numerical value for each fork used. For illustrating the kind of constants one might expect to obtain the values of $\triangle$ for three groups of tuning forks are given in Table III. For convenience the values of K from Table I are also given. The first group of forks are from a set used in the Bell Telephone Laboratories. The second set was loaned to us by Dr. E. P. Fowler. The last fork is a 500 cycle standard fork used by Dr. Douglas MacFarlan.

For example, when Dr. Fowler's 256 fork is used the per cent hearing loss is given by

$$\text{Per Cent Hearing Loss} = 1.25(70 - t)$$

where t is the air conduction time for the patient. It is evident from the formula that if a person does not hear the fork at all, he must have more than 87½ per cent loss.

TABLE III

TYPICAL CONSTANTS FOR TUNING FORKS.

Rate in dv	Dampening Δ Expressed in SU per second Bell Telephone	Time t_o in seconds for Normal Air Conduction Laboratories' Forks	Factor K for Reducing Hearing loss to % Hearing
24	.30	75	4. (?)
48	1.9	51	2.2 (?)
64	1.61	41	1.5
100	1.75	30	1.28
200	.93	110	.96
400	.46	140	.83
500	.59	135	.81
800	.87	112	.77
1000	1.19	71	.76
1200	1.14	69	.76
1800	2.29	44	.77
2000	2.41	45	.77
	Dr. E. P. Fowler's Forks		
128	1.08	65	1.09
256	1.38	70	.91
512	1.31	95	.79
1024	1.70	40	.76
2048	2.17	20	.77
	Dr. D. MacFarlan's Standard 500 Cycle Fork		
500	2.0	55	.81

It is useful to know (See Appendix D) that if the hearing loss of the tester is known, then the hearing loss of the patient can be found as follows: Set the fork into vibration by any means not necessarily using a standard blow, hold the fork to the patient's ear in the standard fashion. Start the stop watch when the patient signals he no longer hears the tone. Hold the fork to your own ear in the same standard way, stop the watch when you cease to hear the tone. Then the reading of the watch in seconds multiplied by the constant of the fork Δ gives the difference in sensation units between your hearing loss and that of the patient.

This method has the advantage that the results are not dependent upon the initial blow given to the fork, but it has the disadvantage that it depends upon the hearing of the tester and any noise in the

room affects the hearing of the tester much more than that of the patient provided the former is much more acute than the latter.

For example, suppose that you know that the tester's hearing loss is 20 SU at 2048 vibrations per second, and also when using the technique described above and Dr. Fowler's 2048 fork the time difference is found to be 48 seconds. Then, the hearing loss of the patient is

$$1.70 \times 30 + 20 = 71 \text{ SU}$$

or his per cent hearing loss is

$$71 \times .77 = 55\%$$

It would be a great advantage to those who use tuning forks if the makers of such forks for otological purposes would furnish values of the damping constants as well as the frequency of vibration: then the results of tuning fork tests could be reduced to a common basis as indicated above.

From the relations given above it is evident that the common practice of giving the results of tuning fork tests as fractions is not a rational one. Two such fractions that are equal do not indicate at all that the hearing losses corresponding are equal. For example suppose a man having 60 SU loss in hearing were tested first with the 500 fork of the Bell Telephone Laboratories' group and then with Dr. MacFarlan's fork. In the first test the hearing time for the patient would be 33 seconds and in the second 25 seconds. Expressed as ratios in the usual way these give 33/135 or approximately ¼ and 25/55 or approximately ½. By giving just these two ratios one would never guess that they referred to the same hearing loss. However, if they are reduced to sensation units as outlined above, it will be found that a 60 SU hearing loss is obtained from both tests. Or, again if the 100 cycle and the 2000 cycle forks were used and the hearing times found to be 10 and 15 respectively, expressed as ratios of times the hearing loss would be ⅓ in each case, but the ability to hear these tones is vastly different the hearing loss for the first being 35 SU and for the second 72 SU.

NEW INSTRUMENTS AND METHODS FOR DETERMINING DIRECTLY THE HEARING LOSS IN SENSATION UNITS.

In order to increase the accuracy and speed of making hearing tests which are equivalent to those which have been described and for the purposes outlined at the beginning of the paper, the Bell Telephone Laboratories have developed several pieces of apparatus which I wish to present for your consideration. For making speech tests a phonograph type of audiometer has been developed. In this

instrument records which have been made by special electrical processes are used for producing the speech sounds. This insures a definite volume of voice so that accurate comparisons are possible. The recorded speech sounds are transformed into their electrical equivalent by means of an electromagnet reproducer. The electrical waves thus created are carried by means of wires to a receiver which is held to the patient's ear. The intensity of the sound sent into the patient's ear is controlled by resistances in the electrical circuit. This phonograph type audiometer is furnished in three different forms according to the purpose for which it is to be used. For making a survey of the hearing of large groups to find those who have a deficiency for hearing speech it is furnished with the turntable unit, with special records upon which the recorded speech sounds continually decrease in intensity as the record revolves, and a unit containing 12 receivers. A master sheet is furnished which gives the hearing loss corresponding to 50 per cent failure to understand numbers pronounced with intensities equivalent to those produced by each number on the record. This form of phonograph audiometer requires no batteries or attenuators. (Demonstrated the use of this instrument by permitting 24 of the doctors present to listen to some of the records.)

For purposes of testing more accurately the hearing of one individual at a time an attenuator is interposed between the turntable unit and the receiver and a record is used which gives a constant speech intensity. For use in schools for the deaf or for testing patients who are very hard of hearing an amplifier unit which obtains its power supply directly from an AC lighting circuit can be furnished to be interposed between the turntable unit and the attenuator box. (Demonstrate the use of this instrument with a 25-A amplifier.) In each case the connecting cords are arranged so that the tester can also listen by means of an auxiliary receiver to the speech coming from the phonograph record. This phonograph type of audiometer can also be used as an auxiliary to either the 2-A or 3-A audiometer. When used in this way the hearing loss can be read directly on the audiometer dial. (Demonstrate its use on both the 1-A and 2-A audiometer.) With this instrument the speech intensities being delivered to the ear of the patient can be varied 10 billion fold by simply turning the dial from one end of the scale to the other corresponding to a distance variation of more than 100,000. This makes it possible to test ranges of deafness from zero loss to 100 SU loss or practically the entire range. Not only does it have this increased range over that obtainable in the ordinary

speech test, but it has a determinable intensity level for the speech and is not subject to variations in the acoustic properties of the room.

The 3-A audiometer which has been described before has been developed to take the place of such tests as the watch tick tests, the acoumeter tests, or those designed to make a very quick test of the general hearing level. In this instrument a tone having components throughout the entire speech frequency range electrically generated and delivered to a receiver to be held on the ear of the patient. The volume of the tone is controlled by the same attenuator unit as used

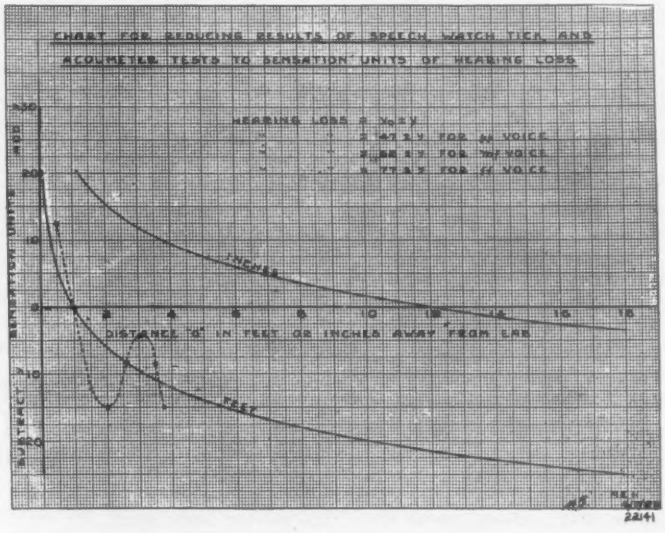


CHART FOR REDUCING RESULTS OF SPEECH, WATCH TICK AND
ACOUMETER TESTS TO SENSATION UNITS OF HEARING LOSS
HEARING LOSS
SENSATION UNITS
INCHES
FEET
DISTANCE "S" IN FEET OR INCHES AWAY FROM EAR
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in the other audiometers. It reads directly either in sensation units loss or per cent hearing loss since it was found for this tone that there were just 100 SU between the threshold of hearing and the threshold of feeling for the normal ear. This instrument has been found to be particularly useful in schools for the deaf. It enables the teachers to grade the degree of hearing of the child very quickly which aids them in deciding upon the kind of methods to be used in teaching him. It is also useful in making a quick test of the hearing of large groups when they are to be tested one at a time. (Demonstrate the performance of the 3-A audiometer.) This 3-A audiometer is also useful when testing a case of uni-lateral deafness for it can be used to produce a determinable amount of noise in the

good ear while testing the acuity of the bad ear by any of the methods outlined. For this purpose it is much superior to a device which produces only a constant level of noise because the intensity of the noise can be placed at just the proper level to sufficiently mask the hearing in the good ear without in any way interfering with the hearing in the bad ear. The proper level for doing this depends upon the relative amounts of hearing in the two ears. Those who believe an ear massage is of value may find that this instrument can be adapted to this purpose.

The apparatus which has been developed for replacing the tuning fork test is now quite well known. Several types of audiometers have been developed for this purpose. The two which have been developed by the Bell Telephone Laboratories and known as the 1-A and 2-A audiometers are here for demonstration. These two audiometers are devices for diminishing the intensity of the sound logarithmically to just the inaudible point exactly as the tuning fork is a device for letting the intensity fall off logarithmically in time to just the inaudible value. The 2-A audiometer has been designed for general practice and for this reason great stress has been placed on the convenience and simplicity of its operation. Eight tones spaced an octave apart in the frequency range from 64 to 8192 vibrations per second can be produced by throwing the appropriate keys on the keyboard of the audiometer. The attenuator scale is calibrated so that the hearing loss in sensation units is read directly from the scale when the dial is turned to the position corresponding to the threshold for the patient being tested. Audiogram blanks are furnished with the instrument which makes it possible to show graphically the hearing loss at each frequency. Already a number of doctors have changed the form of these blanks to fit their particular need, but of course have retained the same scale.

The 1-A audiometer is similar in principal to the 2-A audiometer but it has a much greater range in frequency and intensity. Both of these instruments are equipped with a jack so that auxiliary equipment may be used with them. It has been our experience that the doctor frequently desires to talk to the patient either before or during the time that the pitch range test is being made. For this purpose a talking set has been developed. By plugging the end of the cord of the talking set into the jack of the audiometer it is possible to talk directly to the patient through the receiver which he is using during the test. By turning the attenuating dial the volume of the speech thus delivered to the patient's ear can be varied in intensity from high values to the threshold of audibility. (Demon-

strate the use of this instrument on both types of audiometers.) Also, as mentioned before, the phonograph audiometer may be used as an auxiliary to both the 1-A and 2-A audiometers by plugging the cord from the turntable unit of the phonograph audiometer into the appropriate jack. Then, the speech waves coming from the phonograph record will be delivered directly to the receiver of the patient's ear. Its volume may be controlled by the attenuator dial. A mark on this dial can be determined so that readings on the scale from this mark will give directly the patient's hearing loss for speech.

In schools for the deaf and other places where large intensities are required and where the expense of a 1-A audiometer may not be justified, the intensities of the 2-A audiometer may be increased by adding the amplifier unit used in connection with the phonograph audiometer. This amplifier can be used with the 2-A audiometer by a very slight modification in the present type. Such an audiometer is available. (Demonstrated the use of the 25-A amplifier with the 2-A audiometer.)

For research purposes any or all of this apparatus might be used. It may be modified in a great variety of ways to suit the investigator. For example, three different types of pitch range audiometers have been discussed before this Society in which a continuous variation in pitch was possible.

It has been our opinion that except for special research work this is not necessary or even desirable. However, for those who like the other features of the 1-A audiometer and still want a continuous variation in frequency I will state that a standard Leeds Northrup condenser box can be connected into the circuit so that all frequencies besides those normally obtained can be produced. When the audiometer is thus converted a calibration curve is required for interpreting the results. (Demonstrated how this may be done.)

Comparative Results of Different Methods for Ten Patients.

In order to show comparative results obtained by different methods of testing, Table IV is given. It shows the results of tests on the hearing of ten persons by four different methods, namely, the phonograph audiometer, the 3-A audiometer, the standard speech test, and the watch tick test methods. Audiograms obtained by the 2-A and 1-A audiometers are given for these same people in Fig. 3. On these audiogram charts the hearing loss for speech and for the 3-A audiometer tone are shown at the left and right respectively.

TABLE IV.

I	II			III		IV	V			VI		VII
Ear Number	Distances for Interpreting Numbers Voice A Y-58	Voice B Y_0-65	=	Hearing Loss Cal. from II		Hearing Loss Phonograph Audiometer	Distances for Watch Tick Test A(Y_0-10)	B(Y_0-15)	=	Hearing Loss Cal. from V		Hearing Loss 3-A Audiometer
1–R	800 ft. (cal.)	1800 ft. (cal.)		0	0	0	40 in.	70 in.		0	1	0
1–L	"	"		0	0	0	20	36		6	5	0
2–R	140 ft. (cal.)	320 ft. (cal.)		15	15	15	10	31		12	7	10
2–L	"	"		15	15	15	15	64		8	2	10
3–R	20 ft.	20+ft.	+	32	7	30	3	5½		22	22	30
4–L	3 "	6 "		48	49	35	–	1		—	39	35
5–L	1.7 "	3.7 "		53	54	45	2	4.5		26	23	40
5–R	1.8 "	3.7 "		52	54	50	3	6.5		22	21	45
6–L	2 "	3.5 "		52	54	50	–	contact			55	45
6–R	1.5 "	4 "		54	53	45	–	.5			45	45
7–R	.9 "	2 "		57	59	50	–	contact			55	45
8–L	1.2 "	3.7 "		56	54	60	–	–				50
8–R	1.2 "	3.7 "		60	54	60	–	contact			55	50
4–R	No test					65	–	–				65
9–L	8 in.	13 in.		62	64	65	–	–				60
9–R	5	8.5		65	68	70	–	–				60
7–L	8	15		61	63	70	–	–				65
10–R	3.5	9		69	68	70	–	–				45
10–L	2	6		74	71	75	–	–				60
3–R	No Test					90	–	–				80

The black rectangle represents the watch tick results. A comparison of the results shown in columns III and IV shows that the phonograph audiometer gives results which are in good agreement with the reduced results from the standard speech tests. The differences are well within the observational error.

The watch tick results are just what one would expect from the amplitude frequency characteristic of this type of sound. It is interesting to note that if patients 3 and 5 were given a watch tick test only they would be considered to have the same amount of hearing, but further tests showed that patient 3 could hear speech at 20 feet while patient 5 could hear it only 2 feet away. It is evident from the audiograms why this is true. Patient 5 hears the high frequencies very much better than the low frequencies. An examination of the various audiogram charts indicates that the 3-A audiometer reading gives a good criterion of the general hearing level. However, results obtained by it are not definitely correlated to the hearing loss for speech, although there is a general agreement. A notable exception is the lack of agreement in the results obtained by patient 10. The 3-A gave 45 SU for the right and 60 SU for the left ear. The phonograph audiometer gave the hearing loss for speech as 70 SU for the right and 75 SU for the left ear. An examination of the audiogram for patient 10 shows why this should be. The important frequencies for speech interpretation, that is, from 500 to 2000, are considerably below the general level, the low frequencies being the highest. This is also true for patients 8 and 9. For patient 5 the speech frequencies are on about the same level as the low frequencies, but very little loss is shown for the high frequencies. In this case it is probable that the 3-A audiometer tone was heard because of components between 2000 and 8000 vibrations per second.

Method of Calculating Hearing Loss for Speech from an Audiogram.

Our studies on speech and hearing have indicated that the important frequencies for interpreting speech are between 500 and 2000 vibrations per second. The simple method of taking an average of the hearing losses at 512, 1024, and 2048 for determining the hearing loss for speech gives results in good agreement with observations on these 10 patients. In Table V is shown a comparison of results thus obtained. The observed values are averages of the figures given in columns III and IV of Table IV. The per cent hearing loss is obtained by multiplying the figures by .83. Until more

accurate methods are devised this simple procedure will be useful in calculating from the audiogram, the per cent hearing loss for speech which is the figure of greatest interest to the patient.

Summary of the Different Methods of Testing the Acuity of Hearing.

In conclusion then it has been shown that to determine the hearing loss in sensation units for speech the following methods may be used.

1. *Voice Tests.* At a distance of one foot whisper numbers at average intensity. If understood, hearing loss is less than 32 SU. Then find maximum distance of hearing for average whisper. From Table II find corresponding hearing loss in column 2. If average whisper is not understood at one foot distance, repeat the test, using loud whisper or PP voice. If then understood, the hearing loss is less than 47 SU. Find maximum distance for hearing

TABLE V.

HEARING LOSS FOR SPEECH.

Ear Number	Calculated from Audiograms	Observed Average
1—L	2	0
1—R	2	0
2—L	20	15
2—R	16	15
3—L	39	31
3—R	89	90
4—L	40	40
4—R	72	65
5—L	52	50
5—R	61	55
6—L	55	50
6—R	48	50
7—L	48	50
7—R	73	70
8—L	61	58
8—R	60	58
9—L	68	65
9—R	72	70
10—L	75	75
10—R	66	70

loud whisper and look up corresponding hearing loss in column 3. If PP voice is not understood at one foot distance, use MF voice, using column 4 to reduce results. Finally, if MF is not understood, use FF voice and proceed as before in previous cases, using column 5. When greater accuracy is desired determine Y_0 for the voice intensity used and read hearing loss from curve of Fig. 1 (Appendix C). In cases of unilateral deafness use 3-A audiometer

or some equivalent for introducing a definite amount of noise into the good ear while testing the bad ear.

2. Phonograph Audiometer. When testing one patient at a time adjust the receiver to ear being tested and ask patient to repeat numbers that he hears. By means of auxiliary receiver check the correctness of his interpretation. Turn attenuator dial until the patient is calling only about 50 per cent of the numbers correctly. Read hearing loss on the dial. In cases of unilateral deafness no noise is required for masking hearing in the good ear while testing the bad ear unles the difference in hearing of the two ears is greater than 50 SU.

When testing a group of 12 or 24, ask the subjects being tested to write down the numbers as long as they can possibly hear them. It is convenient to use special blanks prepared for this purpose. Compare their written record with the master sheet. The average of hearing losses corresponding to the last three numbers written is taken as the hearing loss for speech.

3. Hearing Loss for Speech Calculated from Audiogram. If an audiogram has been taken which shows the loss at each frequency, the approximate hearing loss for speech can be obtained by taking an average of the hearing loss at pitches corresponding to 512, 1024 and 2048 vibrations per second. To convert from hearing loss in sensation units to per cent hearing loss for speech, multiply by .83.

To determine the hearing loss in sensation units for pure tones of various pitches, that is, to obtain an audiogram, the following methods can be used.

1. Tuning Forks (Constant Initial Amplitude). At the time of giving the fork a standard blow start the stop watch. Hold the fork to the patient's ear in standard way. Stop watch when the patient signals he no longer hears. Subtract the time in seconds given by the stop watch from the normal hearing time and then multiply by a constant of the fork to obtain the hearing loss in sensation units. For increased accuracy repeat the test several times. Proceed in this way for the entire pitch range of tuning forks.

2. Tuning Forks (Comparison with Hearing of Tester). In this method it is not necessary to maintain a standard initial amplitude. After striking the fork hold to patient's ear. When he signals he no longer hears, start the stop watch. Transfer tuning fork to

your own ear and stop the watch when you last hear the sound. The reading of the stop watch, multiplied by a constant of the fork, gives the difference in hearing loss between your ear and that of the patient.

3. Pitch Range Audiometer. Adjust receiver to ear of the patient. Turn the attenuator dial until patient no longer hears sound. Check the threshold point thus obtained by throwing the sound on and off by means of a push button and asking the patient to signal the on and off time by means of the signal switch.

If using a 1-A or 2-A audiometer the dial reads directly the hearing loss in sensation units. When using other types of audiometers a calibration curve can be constructed to reduce the results to sensation units.

To obtain a quick test of the general level of hearing loss for the entire pitch range use the 3-A audiometer. After adjusting the receiver to patient's ear, turn the dial until he no longer hears. The dial then reads directly the per cent hearing loss.

If the results of the various hearing tests are reduced to hearing loss units as indicated then *the results of one observer will be directly comparable with those of another.*

APPENDIX A.

The relation between hearing loss in sensation units and the maximum distance for hearing and interpreting speech is established as follows. It is well-known that the intensity of sound decreases as the inverse square of the distance from the source. This is true only where there are no solid objects in the vicinity which cause reflections. Stated mathematically

$$\frac{I}{I_0} = \frac{d_0^2}{d^2} \qquad (1)$$

where I is the intensity at a distance of d and I_0 the intensity at a distance of d_0 from the sound source. From the definition of hearing loss given

$$\text{H.L.} = 10 \log \frac{I}{I_0} \qquad (2)$$

Combining (1) and (2)

$$\text{H.L.} = 20 \log \frac{d}{d_0} \qquad (3)$$

As stated in the paper it has been found that the speech sounds entering a normal ear from a caller whose lips are 1½ inches or ⅛

foot from the opening of the ear canal may be attenuated 80 SU before 50 per cent of the called numbers are misinterpreted. This was determined experimentally by means of a high quality telephone system into which was introduced an attenuator similar to those used on the Western Electric audiometers. The dial of the attenuator was first set so that the speech emerging from the telephone receiver had an equal intensity to that produced when talking directly into the ear at ⅛ foot distance. The attenuator was then turned until the person of normal hearing could only interpret half of the numbers called. The difference in the settings was found to be equal to 80 SU. In a similar way it was found that the corresponding differences when an average whisper, or PP voice, and a FF voice was used were approximately 50 SU, 65 SU and 95 SU respectively.

The normal distances for interpreting numbers can be obtained from these figures. From equation 3 it follows that

$$d_0 = \tfrac{1}{8}\ 10^{\frac{50}{20}} = 39.5 \text{ feet for the average whisper}$$

$$d_0 = \tfrac{1}{8}\ 10^{\frac{65}{20}} = 222 \text{ feet for the PP voice}$$

$$d_0 = \tfrac{1}{8}\ 10^{\frac{08}{20}} = 1250 \text{ feet for the MF voice, and}$$

$$d_0 = \tfrac{1}{8}\ 10^{\frac{95}{20}} = 7040 \text{ feet for the FF voice}$$

Using these values for d_0 and equation (3) the corresponding values of hearing loss H.L. and distance d given in Table II were calculated.

APPENDIX B.

Let the maximum distances for hearing the average whisper, PP voice, MF voice, and F voice be d', d'', d''', and d'''', for the patient, and d_0', d_0'', d_0''', and d_0'''', for a person of normal hearing. Then from equation (3), Appendix A,

$$20 \log \frac{d_0'}{d'} = 20 \log \frac{d_0''}{d''} = 20 \log \frac{d_0'''}{d'''} = 20 \log \frac{d_0''''}{d''''}$$

or,

$$\frac{d_0'}{d'} = \frac{d_0''}{d''} = \frac{d_0'''}{d'''} = \frac{d_0''''}{d''''} \qquad (1)$$

This equation states that regardless of the intensity of voice used, the ratio of the hearing distance for the normal ear to that for the

ear of the patient is the same. Let x', x'', x''', and x'''' be the increased hearing distances corresponding to a hearing improvement q for the four types of voices. Then

$$q = 20 \log \frac{d_0'}{d''} = 20 \log \frac{d_0'}{d' + x} = 20 \log \frac{(1 + x')}{(\quad d')}$$

Similarly

$$q = 20 \log \frac{(1 + x'')}{(\quad d'')} = 20 \log \frac{(1 + x''')}{(\quad d''')} = 20 \log \frac{(1 + x'''')}{(\quad d'''')}$$

or,

$$\frac{x'}{d'} = \frac{x''}{d''} = \frac{x'''}{d'''} = \frac{x''''}{d''''} \qquad (2)$$

Combining equations (1) and (2)

$$\frac{x''''}{x'} = \frac{d_0''''}{d_0'} = \frac{7040}{39.5} = 178$$

$$\frac{x'''}{x'} = \frac{d_0'''}{d_0'} = \frac{1250}{39.5} = 31.7$$

$$\frac{x''}{x'} = \frac{d_0''}{d_0'} = \frac{222}{39.5} = 5.6$$

This leads to the very important conclusion that if a patient shows an improvement of 1 foot when using the average whisper he will also show an improvement of 5.6 feet, 31.7 feet and 178 feet for the other three intensities of calling. This is true regardless of the amount of the improvement; if it is small, the additional distance will be added to a large distance; if large, to a small distance.

APPENDIX C.

Equation (3) of Appendix A can be written

$$\text{H.L.} = 20 \log d_0 - 20 \log d = Y_0 + Y$$

Construct a curve with ordinates equal to

$$Y = -20 \log d$$

Then by adding ordinates of this curve corresponding to d and d_0 the hearing loss in sensation units is obtained. The numerical values of Y will be positive and must be added to Y_0 for distances smaller than one foot and will be negative and must be subtracted for distances greater than one foot. Fig. 1 shows such a curve for

distances from 1 inch to 18 feet. For greater distances this same curve can be used as follows: For distance 10 times those shown, subtract 20 from ordinate shown; for distance 100 times, subtract 40; for distance 1000 times, subtract 60; and for distances 10,000 times, subtract 80. For example, the Y corresponding to 40 feet is —12—20=—32; corresponding to 400 is —52; corresponding to 4000 is —72. The values of Y_0 for the first four types of calling described in the paper and which correspond to the normal distances for interpretation are 32, 47, 62, and 77 respectively. It was shown in Appendix A that the normal distances for hearing are too large to be determined directly except for intensities lower than the average whisper so that other methods must be used for determining Y_0. If a patient is available whose hearing loss has been accurately determined by audiometric methods a test of his hearing with the intensity of voice which it is desired to use will determine Y_0. For example, suppose a patient's hearing loss is 50 sensation units and a test shows that he hears at a distance of but 1½ feet, then from the curve it is seen that the ordinate Y corresponding to 1½ feet is 2. So, it is seen from the equation above that

$$50=Y_0-2$$

so that for such a voice

$$H.L.=52-Y$$

Assuming that a room is only 20 feet long, the minimum hearing loss that can be measured with this type voice is

$$52-26=26 \text{ SU}$$

Assuming that results are unreliable for distances closer than 6 inches, the maximum hearing loss that can be measured by such a voice is 58 sensation units. This method was used to determine the values of Y_0 shown in Table III. The results shown in columns II and III of this table were computed by the method outlined in this appendix.

APPENDIX D.

It is well known in dynamics that the motion of a tuning fork can be represented by

$$A=A_0 e^{-a(t_0-t)} \cos 2\pi n (t_0-t) \quad \ldots\ldots (1)$$

where t and t_0 are the times at which the fork has the amplitude A and A_0 respectively, and n is the number of double vibrations per second executed by the fork and a is the damping constant. The intensity of sound radiated by this fork and reaching the ear is proportional to the square of the amplitude of vibration. Consequently if I and I_0 correspond to the intensities at times t and t_0, then

$$\frac{I}{I_0} = e^{-2a(t_0-t)} \qquad (2)$$

The hearing loss then by definition is

$$\text{H. L.} = 10 \log_{10} \frac{I_0}{I} = \frac{20a}{2.3}(t_0-t)$$

where t_0 and t correspond to the hearing for the normal ear and the ear of the patient.

The constant $\triangle$ is defined as

$$\triangle = \frac{20a}{2.3} = 8.68a$$

and is the damping expressed in sensation units per second. In other words, $\triangle$ is the number of sensation units that the sound intensity level lowers during each second of time.

If t_1 is the hearing time for the tester, and t_2 for the patient, and $(HL)_1$ and $(HL)_2$ are the corresponding hearing losses, then

$$(HL)_1 = \triangle(t_0-t_1) \quad \text{and} \quad (HL)_2 = \triangle(t_0-t_2)$$

Combining

$$(HL)_1 - (HL)_2 = \triangle(t_2-t_1)$$

Or the difference in hearing time for the tester and the patient multiplied by $\triangle$ gives the difference in sensation units between the hearing loss of the patient and that of the tester.

VALUE OF HEARING TESTS BY THE AUDIOMETER.*

Dr. J. Ivimey Dowling, Albany, N. Y., and R. L. Wegel.**

PART I—CLINICAL DISCUSSION BY DR. J. IVIMEY DOWLING.

The purpose of this paper is to describe briefly the audiometer, its construction, use, its relative value, and to present some original observations covering a large series of cases. In all cases the findings were checked by functional and other tests when indicated.

It is well known that the time that a tuning fork will vibrate depends not only upon the forks themselves, but also upon the force with which they are set in vibration. It has been very carefully determined that the energy applied to a fork by a freely falling weight has an error of 20 per cent. The same fork in the hands of one observer may show fairly constant results while when used by another show a different result because of the force with which one sets the fork in vibration. Also, different forks used by the same observers will have different periods of vibration while, in contrast, *the audiometer gives a pure tone of standard intensity and the minimum intensity necessary to excite the auditory nerve is determined rather than the length of time during which a tone is heard.*

It requires but a short time to learn to take the tests and the error in observation is very small. *In many cases it is possible to make a complete test with this method in five minutes, but it may take longer in persons of sluggish or nervous mental states.*

Since the audiometers are standard an audiogram taken by one observer on his instrument will show the same curve as one taken on a different instrument by another observer, and different observers on the same patient will get results that will not vary more than five sensation units and will present similar curves which permit in each instance similar diagnosis. The facts are well illustrated in Fig. 1.

This immediately strikes one as of prime importance in cases where a patient goes to a different city and is being treated by a confrere, and in the reporting of cases it gives a common ground for discussion and in legal cases a definite loss in percentage may be determined.

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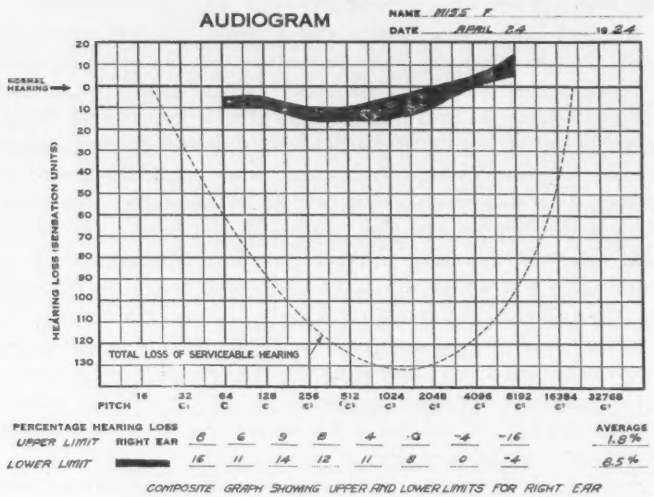
**Research Laboratories of the American Telephone and Telegraph Co., and the Western Electric Co., Incorporated.

Another advantage is to be found in that often times a very good test can be taken of an advanced case of deafness.

In cases of impaired sound conduction, whether due to impacted cerumen, otitis media, with or without perforation of the membrana tympani, otosclerosis, etc., and when the nerve itself shows no lesion either central or peripheral, the characteristic curve shows an increased intensity necessary for audibility for the lower tones more marked than for the higher ones, which necessarily results in a per

FIG. 1



COMPOSITE GRAPH SHOWING UPPER AND LOWER LIMITS FOR RIGHT EAR REPRESENTING THE RESULTS OBTAINED BY FOUR OBSERVERS WITH THE SAME PATIENT.

THE OBSERVERS WERE; A GENERAL PRACTICIONER, A LABORATORY TECHNICIAN, AN X-RAY TECHNICIAN, AND A TRAINED OBSERVER, WHO TOOK TEN MINUTES TO DESCRIBE THE METHOD OF TAKING THE TEST. THE TIME REQUIRED TO TAKE THE TEST WAS 14, 20, 17, AND 5 MINUTES RESPECTIVELY. THE GREATEST VARIATION FROM THE AVERAGE WAS 1.5%

cent drop in the chart curve for low tones. In the curves taken the 512 d. v. tone seems to be about the center between the conduction types and the nerve types. This all corresponds exactly to the results found by testing with the forks where there is a loss for the lower forks especially.

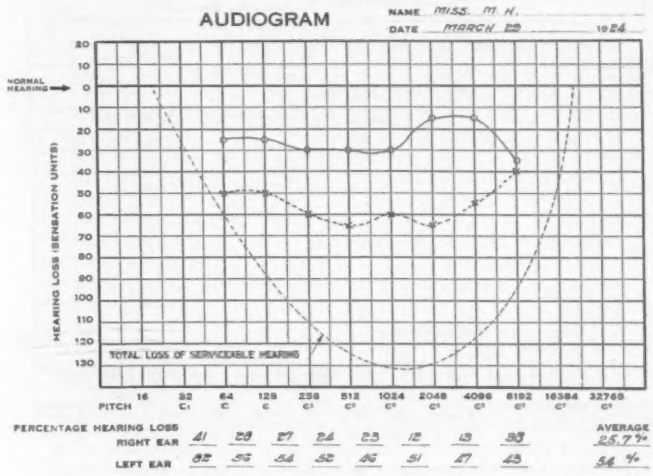
This similarity is also present in cases of nerve deafness when the chart-curve may show a loss for all tones, but especially the high

tones where the curve will take a rapid drop and in the cases of fairly well advanced lesions the patient may not hear them at all.

In the mixed type of cases there will be a decided drop at both ends. When there is a marked difference between the two ears of the same patient, the sound may be perceived in the better ear before it is heard by the poor ear then being tested. So far we have only observed this in two cases.

In all cases where there was a difference of 10 or more sensation units between the two ears a Weber test was made with the corresponding fork. It has been found that the Weber will be to the

FIG. 4


AUDIOGRAM
NAME MISS. M. H.
DATE MARCH 29 1924
NORMAL HEARING
HEARING LOSS (SENSATION UNITS)
TOTAL LOSS OF SERVICEABLE HEARING
PITCH
PERCENTAGE HEARING LOSS
RIGHT EAR 41 28 27 24 25 12 13 38 AVERAGE 25.7%
LEFT EAR 82 56 54 52 46 51 47 45 54 %

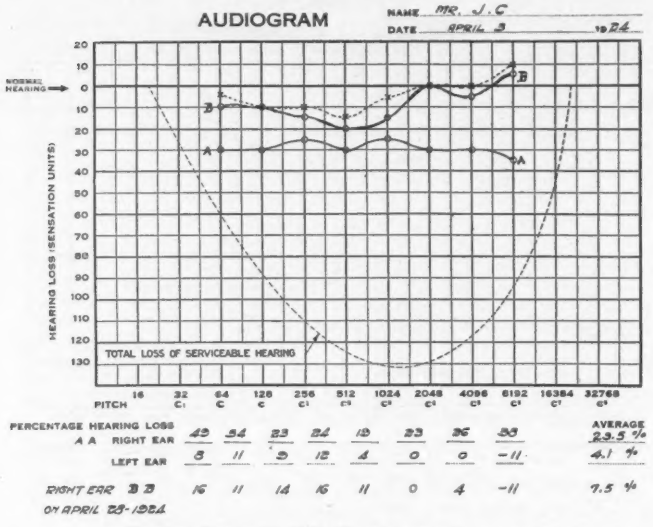
THE WEBER TEST WAS MADE WITH THE FORKS, *128, *256 AND *512 AND WERE ALL TO THE LEFT.

side showing the greater loss in all cases except those which show a nerve deafness on that side, as illustrated in Fig. 4.

In reviewing the cases I wish to call to your attention certain typical cases of the various common types of deafness. The simplest as far as curve is concerned is the case of impacted cerumen or other obstructive disease of the external auditory canal as shown in Fig. 8, which is a chart from a case of exostosis and furuncular abscess of the external canal.

In cases of impaired hearing due to obstruction to the external auditory canal the chart-curve will show the greatest drop for the low tones in cases of simple type. The fineness of the audiometer record is such that it suggests in some cases of this nature an irritable auditory nerve (probably an initial congestion incident to the possible complicating Eustachian tube factor). In such cases the chart-curve for high tones may also show a decided drop which disappears promptly after removal of the offending obstruction in the canal, for the complicating Eustachian tube factor will recover spontaneously upon removal of the obstructing pathology in the external auditory canal.

FIG. 8


AUDIOGRAM
NAME MR. J. C
DATE APRIL 3 1924
NORMAL HEARING
HEARING LOSS (SENSATION UNITS)
TOTAL LOSS OF SERVICEABLE HEARING
PITCH
PERCENTAGE HEARING LOSS
A A RIGHT EAR 45 54 33 24 18 23 36 88 AVERAGE 23.5 %
LEFT EAR 8 11 5 12 4 0 0 -11 4.1 %
RIGHT EAR B B 16 11 14 16 11 0 4 -11 7.5 %
ON APRIL 28-1924
THIS CASE SHOWS CONDUCTION LOSS DUE TO EXOSTOSIS AND FURUNCULAR ABSCESS OF EXTERNAL AUDITORY CANAL WALL OF RIGHT EAR. OCCLUDING CANAL TEST TAKEN WHEN FIRST SEEN ON APRIL 3 1924 AND LATER ON APRIL 28, 1924 WHEN CURED.

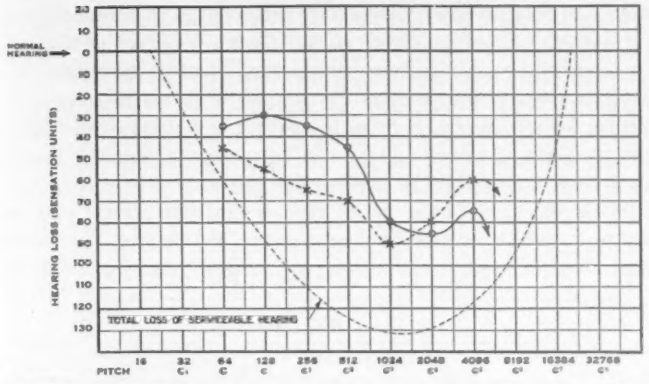
As we glance at a field of vision and say, there is a case of optic neuritis or hemianopsia, as the case may be, so we can look at this curve and at a glance be fairly certan of the diagnosis. It is a picture and a record which may be stated in per cent and so readily comprehended by banker or borrower, rich or poor, doctor or layman.

From this type let us go to the opposite extreme and observe the curve in a pure nerve deafness. Again we have the graphic repre-

FIG. 10

AUDIOGRAM

NAME MISS B.C.
DATE MARCH 6 1924



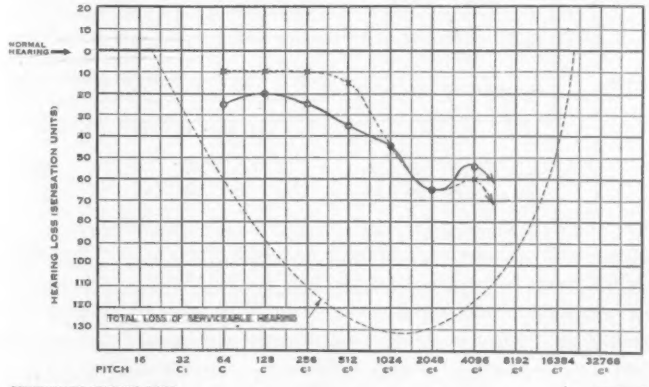
PERCENTAGE HEARING LOSS	16 C1	32 C	64 C	128 C1	256 C2	512 C3	1024 C4	2048 C5	4096 C6	8192 C7	16384 C8	32768 C9	AVERAGE
RIGHT EAR	51	34	32	36	61	66	64						56.2 %
LEFT EAR	74	62	59	56	69	65	51	—					66.7 %

CASE OF NERVE DEAFNESS
WASSERMANN ++ (INHERITED)

FIG. 12

AUDIOGRAM

NAME MRS. B.P
DATE MARCH 7 1924



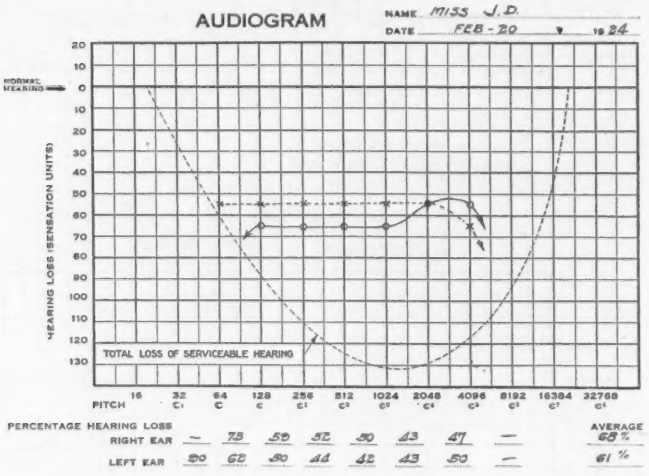
PERCENTAGE HEARING LOSS	16 C1	32 C	64 C	128 C1	256 C2	512 C3	1024 C4	2048 C5	4096 C6	8192 C7	16384 C8	32768 C9	AVERAGE
RIGHT EAR	41	22	23	28	34	51	51	—					43.6 %
LEFT EAR	16	11	5	12	34	51	47						35. %

NERVE DEAFNESS WITH FAMILY HISTORY OF DEAFNESS.
OPERATED SUBMUCOUS RESECTION AND OPENING OF ETHMOID CELLS ONE YEAR AGO. WASSERMANN NEGATIVE.

sentation of the lesion. There may be a marked lowering of the curve throughout but always with a sharp fall after the 512 d. v. pitch. In mild cases all the tones are heard but in advanced cases the curve drops off and the higher pitches are not perceived at the greatest intensity possible of being produced. There is nothing new in this; for we have the same result with the forks, but here we have a picture for our records and for the patient as illustrated in Figs. 10 and 12, taken in cases of nerve deafness, the one showing Wassermann plus 2, the other Wassermann negative.

The audiograms of the mixed type of deafness present two general types which may be read at a glance and suggest the possible basic cause of syphilis or the contrary. Fig. 10 shows a graph of a

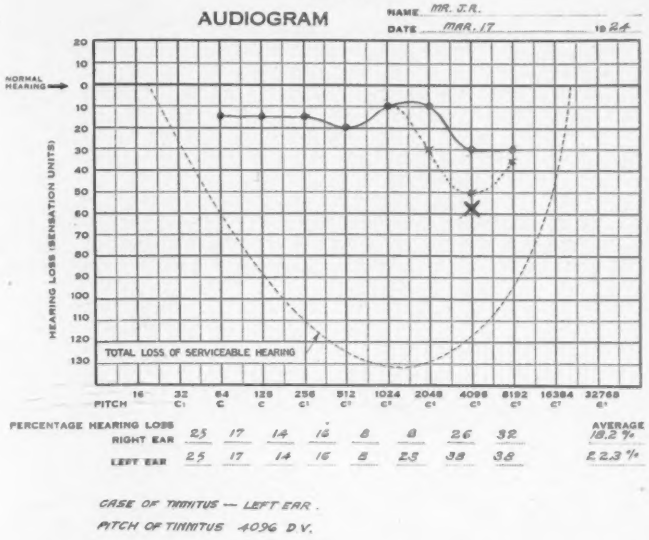
FIG. 14



patient with Wassermann plus 2 in which the loss for the higher pitched tones is in excess of the loss for the lower pitches. This type graph has been found in our cases to be strongly suggestive of syphilis as a basic cause and when noted emphasizes the need for immediate Wassermann being determined. On the contrary Fig. 14 represents a patient with mixed deafness in which the graph exhibits a loss of the low and high pitches more nearly alike. This patient as in others presenting similar pictures showed Wassermann negative. However, the cause is believed to be due to a bacterial toxin originating in the ethmoid cells.

After referring to Figs. 10 and 14 attention should again be directed to Fig. 12, which is a graph of as pure nerve deafness as is ever observed. It will be noted that the graph indicates but comparatively little conduction fault. This patient presented a family history of deafness of sudden onset. Wassermann negative. The deafness occurred as suddenly as blindness ensues in acute glaucoma and is representative of a large group in which the writer believes deafness results because of sudden increase of labyrinthine tension. It is interesting to note that the greatest and most permanent bene-

FIG. 15



fits in this particular type of cases results from radical ethmoid surgery as had been demonstrated in the writer's practice many times.

These conclusions as to graphs taken in the mixed and nerve types of deafness is still *sub judice*, but if corroborated by other observers would prove valuable in that the reading of the primary graph would at once suggest the most appropriate line of treatment.

Some records show islands of impaired hearing or actual loss of hearing as far as we are able to determine with this instrument for some particular tone. These are analogous to the scotoma of the visual fields. As yet it is a little early to predict the great importance of this finding. It is interesting to note that in testing patients

complaining of tinnitus that they are sometimes able to determine the pitch of their tinnitus when that particular pitch is tested. In all cases observed so far in this manner it will be seen that the pitch of the tinnitus will correspond to the pitch which shows the greatest loss of hearing, as evidenced by chart-curve recorded in Fig. 15. Taking for granted that the tinnitus is produced by mechanical means in the sound conducting apparatus, it is reasonable to presume that these drops represent a cochlear lesion which causes the conduction apparatus to operate at impaired efficiency for that pitch. It is interesting to take tests before and after treatment and observe the results obtained.

In stating a final summary as to the value of the audiometer it is possible to state:

1. That accurate tests may be made by office assistant or trained otologist with a minimum of difference in the tests, but with a constant diagnostic value.

2. The recorded graphs are easily interpreted and make possible a tentative diagnosis even before making a fully complete examination of the patient.

3. The graphs visualize to both the physician and patient the defects in hearing and easily suggest the type of disease causing the deafness, that is, whether of the conducting apparatus or of nerve origin.

4. The graphs are analogous to visual charts and are of like value in picturing the hearing loss in per cent.

5. Comparison of sequent charts demonstrates to the patient actual improvement in function or the contrary and are therefore of greater value than tuning fork tests which patients cannot understand.

6. The audiometer makes possible speedy and accurate tests which eventually will prove of no uncertain value in medio-legal cases.

In preparing this paper I wish to acknowledge the help obtained from the reports by Dean, Bunch, Wilson, Minton, Fowler, and Wegel, and Fletcher.

PART II. PHYSICAL DISCUSSION BY R. L. WEGEL.

In the past few years a great deal of attention has been concentrated on the use of the audiometer for diagnosis of ear diseases. The audiometer gives the same sort of data as that formerly taken with tuning forks. There is, however, a difference which appears to be recognized that gives the audiometer a considerable advantage. Otologists have been using tuning forks for a great many years and

have correlated, each man more or less in his own way, the findings with tuning fork tests and physical conditions of the patient. Each otologist has a fairly definite idea of the meaning, therefore, of his tuning fork data as a result of long experience. The audiometer at the present time has the disadvantage of not having its readings thoroughly correlated to different ear conditions. This disadvantage is rapidly disappearing.

Fig. 1 (Wegel) is a picture of the audiometer used in the tests made and described in this paper. It is completely contained in a box about one foot square by two feet long. It consists of a vacuum tube oscillating circuit capable of furnishing very pure waves of

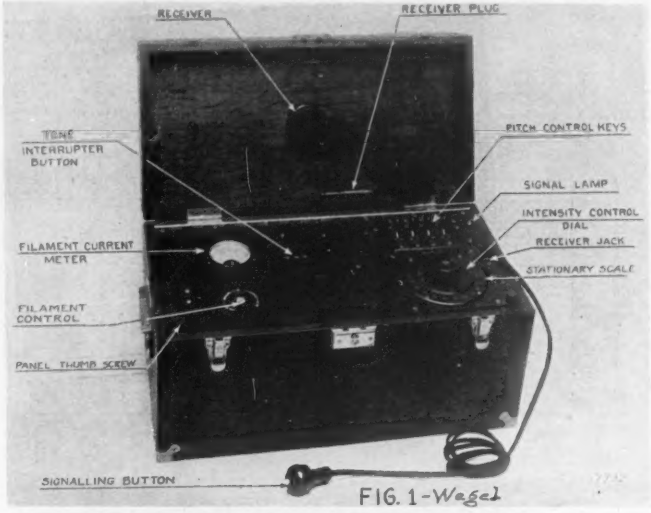


FIG. 1-Wegel

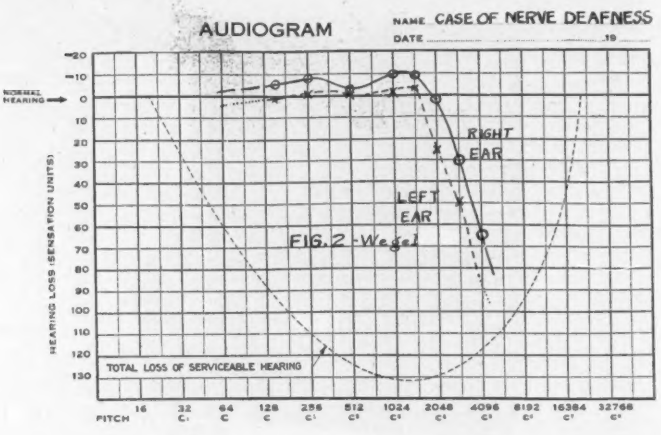
pitches, 64, 128, 256, 512, 1024, 2048, 4096 and 8192 d. v. The apparatus is started by turning the small knob until the ammeter on the panel reads a proper value of filament current. The frequency is varied by means of the four keys in the upper right hand corner of the panel.

The oscillating currents are delivered to an attenuator by means of which they can be varied in definite amounts before being delivered to the damped receiver shown attached to the cover. The variation is done by means of the marked dial in the lower right hand corner, from which hearing loss can be read directly when adjusted so as to be just audible to the patient.

A push button and flash lamp is attached by means of which a patient may signal the operator when he hears a tone. This eliminates the distracting effect of talking and increases the speed and accuracy in making the measurements.

The apparent advantages of the audiometer over the tuning forks are a result of the conciseness and definiteness with which the data can be recorded and transmitted from one doctor to another.

With an audiometer which is working properly there should be no material difference between the findings of different doctors or between the doctors and their assistants. This is not always true in the case of tuning fork tests. In order to give the audiometer readings a maximum of significance, every detail in the mode of pre-



sentation must be carefully worked out. Audiometer readings can be presented on charts in such a way as to have very little significance. Or again, they may be presented so as to have a great deal of significance. It will perhaps be of interest to discuss briefly the method used in charting results taken with the audiometer.

Fig. 2 (Wegel) shows a sample audiogram. This is a plot of loss of hearing at different pitches. Loss of hearing is defined as the difference between the acuity of the average normal ear and that of the subject being tested. In the right ear of this patient, for instance, it will be seen that his acuity for all pitches below about 2048 d. v. he is lightly above the average normal in acuity, but for pitches above this, he is very deaf. The question is usually asked: "How much hearing have I lost?" or, "How much hearing have I left?"

The older method of answering this question is usually to give in terms of the number of feet away from the patient that he can hear a whisper or a watch tick as compared to the same distance for a normal ear. Recent experiments have shown, however, that either of these sounds lose more in intensity in going from close to the ear to a distance of about a foot than they do in going the remainder of the distance across an ordinary room. This means that a distance of a foot or two feet at the far end of the room causes an extremely small change in the intensity of sound, whereas the change of this same amount when very near the ear causes a very large change. Such a percentage figure, while useful in the absence of a better test, is very inaccurate and likely to be misleading. It is rather difficult to define exactly what is meant by total loss of hearing. If a person

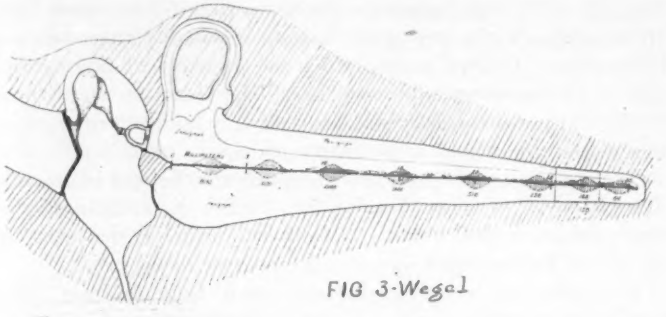


FIG 3-Wegel

has a completely dead auditory nerve, he is, of course, incapable of sensing sound with it and is totally deaf. It is never possible by means of a functional test only to say that a person is totally deaf, because there is always the possibility that if he could be tested with a sound just a little louder than it is possible to obtain he might hear it. We are reduced to the necessity of finding an arbitrary definition of total loss. When a sound is increased to a certain point in loudness, there is a large motion of the ear mechanism which results in a sensation of feeling, that is, in a stimulation of nerves apparently other than the auditory nerve. Sounds as loud as this are very disagreeable to listen to and sometimes result in pain. A large number of measurements have been made at various pitches to determine the intensity of the sound which gives this sensation of feeling. It has been found that for normal ears there is a very definite level which is considerably louder than is obtainable by means of tuning forks. Sounds louder than this can be heard and also felt, but they are of

no use in hearing because of this painful sensation. It is convenient, therefore, to take this threshold of feeling as being the intensity of "maximum audibility". If a person is just so deaf as to feel as easily as he can hear, his audiogram will coincide with the dotted line marked "Total Loss of Serviceable Hearing". The percentage loss of hearing is then the fractional amount of distance between the normal hearing line and that of total loss. For example, in the case of the patient whose audiogram is shown in Fig 2, at 4096 d. v. there is a loss of about 65 sensation units out of a total possible 115. This means a loss a little over 50 per cent. In the left ear at 2048 d. v. there is a loss of 25 sensation units out of a possible 130, or about 20 per cent in hearing.

At very low frequencies there is considerable question as to whether the sounds are heard or felt. The sensation is certainly different than it is at the higher pitches. The same is true of extremely high frequencies. As the audiogram diagram shows, the range between the loudness of sound necessary for the threshold of hearing and that of feeling becomes less and less. The points at which these thresholds approach coincidence, about 20 d. v. to 20,000 d. v., may be conveniently defined as the upper and lower pitch limits. The curves as plotted on this sort of a chart may then be seen in perspective relative to the normal hearing line, the line of total loss and the upper and lower pitch limits. A convenient picture of the extent of the loss is thereby made immediately apparent to the eye.

This patient has been diagnosed as a case of nerve deafness. The middle and external ear are at present very little, if any affected. It is interesting to philosophize on the interpretation pathologically of this audiogram. This can best be done from the standpoint of the latest information and theories available on the mechanism of the performance of the cochlea.

Fig. 3 (Wegel) is a conventional diagram of the ear mechanism with the cochlea unrolled. The basilar membrane is shown with marks along it indicating the number of millimeters from the base. It is taken as being a little over 30 m.m. long. According to the latest information on the dynamics of the ear, we are able to locate the exact spot and its extent on the basilar membrane at which a sound of any pitch stimulates it. The spots stimulated by the different tones of the audiometer are shown. 1024 d. v. stimulates a membrane at about its middle point and the extent or width of the area of stimulation is about 2 m.m. The character of the stimulation due to the particular construction of the mechanism is much the same as would take place if a toothpick with glue on the end of it were

attached to the membrane at that point and moved rapidly up and down. Pitches for the audiometer were chosen so as to test the membrane at equidistant intervals along it. There are gaps between these spots which are not tested, but it is to be presumed that lesions are usually of such a character as to affect a region which is more than 5 m.m. long. When the sounds are extremely loud, of course, the area stimulated is wider than 2 m.m. and hence these gaps are bridged to a certain extent when a very deaf ear is tested.

The case illustrated in Fig 2 (Wegel) shows a very great loss of hearing above 2048 d. v. for the right ear. By reference to this chart it will be seen that pitches normally stimulating the basilar membrane from its origin up to 10 m.m. along its length are not sensed by this patient. One possible interpretation of this is that at some time or other an infection penetrated into the cochlea from the oval window and destroyed the nerve terminals along this length of the membrane, and that the patient has lost the use of the lower third of his basilar membrane. In the left ear the affected area extends a little farther, possibly 11 or 12 m.m. from the base.

There are, of course, other possible explanations for this type of an audiogram but it is hardly worth while to go into them at this time. The above interpretation is given merely as suggestive of what might be done.

THE POTENTIALITIES OF THE AUDIOMETER.*

DR. MAX A. GOLDSTEIN, St. Louis.

The development of the audiometer has successfully passed the experimental stage and we are now concerned with its presentation as an instrument of precision, a means of accurately charting sound as perceived by the ear and a diagnostic aid in the differentiation of types of hearing defects.

In 1897, C. E. Seashore[1] evolved an apparatus which he called an "audiometer", operated by a receiver magnet and electrically-driven toothed wheel with speed-control, by means of which a tonal scale of from 30 d. v. to 7000 d. v. of definitely measured intensities was utilized to determine the range of audition of the human ear.

L. W. Dean and C. C. Bunch[2] applied a modification of this apparatus which they called the Iowa Pitch-Range Audiometer in a study of defects in hearing in a series of cases in the Otologic Clinic of the University of Iowa and to them should be accorded credit for the first application of an audiometer in otology.

The earlier principle of the motor-driven cog-magnet audiometer as devised by Seashore and Bunch has been superseded by the vacuum-tube oscillator and the adoption of radio principles. The first application of the oscillating tube principle for audiometry was described by John Guttman,[3] of New York. Newer forms of audiometer include models of the Western Electric Company, introduced by R. L. Wegel, Harvey Fletcher and E. P. Fowler; the University of Southern California, by V. O. Knudsen and Isaac H. Jones; the Riverbank Laboratories by F. W. Kranz and A. G. Pohlmann.

At the close of the Thirtieth Annual Meeting of the American Laryngological, Rhinological and Otological Society in St. Louis, May, 1924, most of these models were given a practical demonstration at the Central Institute for the Deaf and an informal discussion of their respective merits and shortcomings furnished an interesting introduction to the important problems of standardization and unification, calibration, graphing and simplicity of operation. Among the outstanding features in this discussion, emphasis was given to the following:

THE TONAL RANGE.

The tonal range in the construction of the audiometer should include the full maximum limits of normal audition—16 d. v. to 24,000 d. v. This would make possible the measurement of audition

*Presented at the Fifty-eighth Annual Meeting of the American Otological Society, Washington, D. C., May 5, 1925.

and recording by audiogram of the complete range of sound appreciation in the human ear for even the most delicate research.

THE TONE INTENSITY.

Tone intensity developed in the audiometer is measured in terms of dynes. For the usual functional test of audition, as conducted in clinic or private practice, the otologist would find a sound intensity of one hundred and twenty dynes ample to graph most of his cases within the range of serviceable hearing. As the audiometer, however, serves the additional purpose of determining the capacity of an ear that is profoundly deaf, as is the case in many congenitally deaf children, an increase in the sound intensity to at least two hundred (200) dynes is urged.

BONE CONDUCTION.

The sound in pitch and intensity, as produced by the audiometer, is conveyed to the ear from the disc of the head pieces or ear-phones by air conduction. Many of our former functional tests of hearing are made by differentiation of a sounding tuning-fork between air-conduction and bone-conduction and as these acoustic principles serve as substantial factors in such differential diagnosis in otology, it was recommended that a special bone conduction receiver for carrying out bone conduction tests be added to the equipment.*

The use of a special bone-conduction receiver will necessitate an additional normalcy line and normalcy curve on the audiometer chart, for the graph of bone-conduction audition must be considered as an independent standard and cannot be recorded in the terms of the graph of air-conduction audition.

CALIBRATION AND RECORDING.

One of the most important factors to be determined in the use of the audiometer is a uniform standard of calibration and a uniform standard of recording results of functional tests. The method of calibration is exclusively within the realm of the physicist and as this is based on exact mathematical and electrical measurements, there should be no difficulty about unification of a standard. Stepping off the measurements of sound intensity in divisions of ten dynes each, calibrating all dials for this purpose and ruling all audiograms in squares of ten dynes each seems to be a simple solution of this difficulty. The Western Electric Company seem to have solved the question of accuracy and simplicity in the charting of an audiogram. The heavy horizontal line drawn across the chart at the level of zero dynes represents the *line of normal hearing* and all dials

*Simple forms of bone-conducting receivers were demonstrated at Central Institute for the Deaf, at the Audiometer Conference in May, 1924, by Knudsen, Kranz and Pohlmann.

and indicators on the audiometer are arranged to conform to this normalcy. Extending from this normal hearing line is an irregularly-shaped *u* curve, ranging from a pitch of 16 d. v. to 20,000 d. v. and dipping to beyond 130 dynes in the area of most serviceable hearing (speech area 300 d. v. to 3000 d. v.). This chart offers a simple, comprehensive and dependable form for recording any aype of hearing defect in the range of otology.

I offer a plea for the general adoption of this form of chart as prepared by the Western Electric Company with such modifications as increasing the chart squares to accommodate the seven musical inter-

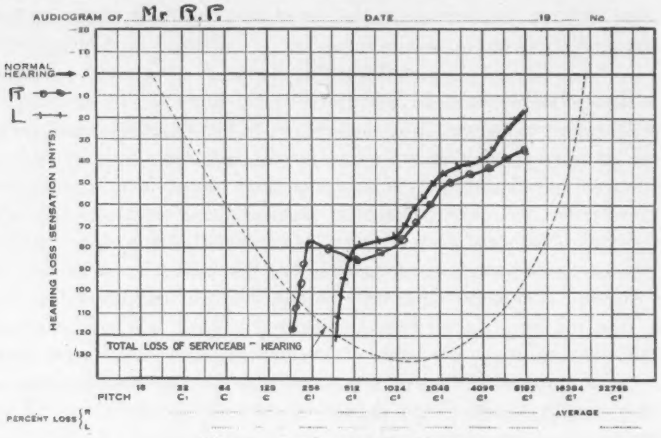


Fig. 1. Conduction Deafness.

This patient, aged 21, has a congenital bi-lateral microtia with absence of both external auditory canals. Patient understands ordinary conversational speech very well.

vals to the octave and the lengthening of the chart to include two hundred dynes of intensity and additional space for recording the results of bone-conduction. With these modifications, this chart covers clearly and simply the necessary and salient features in the production of an audiogram or graphic record of a functional test so standardized that it may be intelligently read from coast to coast by any otologist or investigator so that the story of the audiogram, once told, becomes an invariable record.

TONE INTERVALS.

Of the various types of audiometers demonstrated, one had but two intervals in pitch to the octave and another a sliding scale between octaves. For refinements in test and for determining the possible presence of tone-islands and tone-gaps, I suggest that the usual

standard of musical scale with seven definite intervals to the octave be included in the construction of the larger, research models of audiometers.

Dips in the graph of a given audiogram may be found at certain intervals in the scale, as tested by one-step and two-step instruments which, if recorded with the seven-step instrument, may present an entirely different graph for analysis.

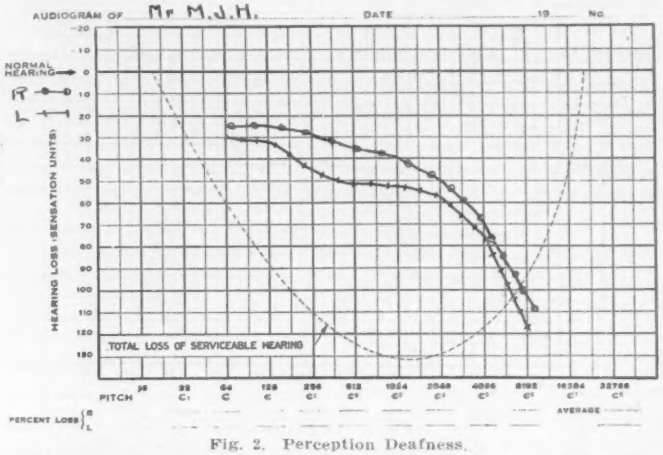


Fig. 2. Perception Deafness.

This patient, a business man, age 46 years, states that about four years ago he suddenly had pain in and around each ear. This condition was diagnosed as neuralgia by the family physician and persisted for about three weeks. Shortly after this time he became aware of the fact that the right ear seemed to be quite deaf and a few weeks later the left became similarly affected. At the beginning of this condition he had no tinnitus of any sort but now occasionally has some high-pitched tinnitus which he cannot lateralize to either ear but says it seems to be in his head. Patient has never had discharge or other difficulty with his ear. There is no history of deafness in his family. Paracusis Willisi negative. Patient denies venereal infection.

A diagnosis of probable syphilis was made from this record and the patient sent to the laboratory for Wassermann. Reaction return four plus.

PRACTICAL APPLICATION.

There are some definite deductions, dependent on clinical and pathological changes that have made it possible to lay down certain principles for the differential diagnosis of a defect in hearings:

1. *Conduction Deafness.* Where there is a defect, even of slight degree, in any part of the conducting mechanism of the ear, such defect will be definitely graphed on the chart by a reduction in the perception of the lower-pitched tones in the hearing range. In defect of the sound-conducting apparatus, therefore, we must expect to find a deflection from the normal hearing line in the low-pitch

range; the graph in the high-pitch range will still approximate the line of normal hearing.

2. *Perception Deafness.* In perception-deafness or nerve-deafness, there will be a diminished appreciation for the high-pitch tonal range and where there has been sufficient pathology developed, the upper range may be distinctly curtailed; in other words, in nerve-deafness the perception of 16,000 d. v. may be entirely lost and at

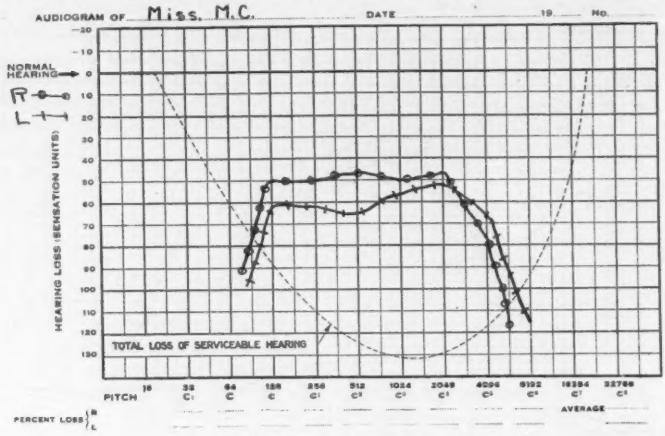


Fig. 3. Otosclerosis.

This patient, age 31 years, comes in complaining of tinnitus, bilateral, and progressive deafness. She has never had a suppuration in either ear and both ear-drums are normal save for slight loss of luster and retraction. She states that about five years ago she began having high-pitched noises in each ear. Following this it was only a short time until she became conscious of the fact that she did not hear as well as formerly. The deafness has been progressive and the tinnitus is still present. There is no family history of deafness that she is aware of. Paracusis Willisi is very marked in this case.

that the balance of the tonal scale all the way to 32 d. v. may still approximate the line of normal hearing.

Another observation which the audiometer makes definitely possible is the reduction in the upper tone limit for otherwise normal-hearing individuals over the age of fifty, due to bone rarification and to a natural reduction in sensitivity in the auditory end-organ.

3. *Otosclerosis.* One of the landmarks in clinical otosclerosis that has been deduced by means of tuning-forks is the reduction in sound-perception for both ends of the tonal scale. In a classic audiogram of otosclerosis there will be found a reduction of sound perception for the entire tonal scale with an absence of tone-perception for 32 d. v. and, in some instances, of 64 d. v. of the lower tonal range and a similar absence of tone perception for 8192 d. v. and even 4096 d. v. of the upper tonal range. In many cases the audio-

gram will indicate the degree and profundity of the otosclerotic process.

4. *Congenital Deafness.* The introduction of the audiometer offers us an additional means of determining the absence of residual hearing in congenitally deaf children, the degree and limitations of this type of deafness and the area of the tonal range in which this deafness is most profound.

The speech area, that part of the tonal range in which the human voice in its various combinations of vowels and consonants, of modulations and pitch, is produced, lies within the limits of 300 d. v. to 3,000 d. v. When a congenitally deaf child, tested with a high-powered audiometer intensified to 200 dynes, no longer evinces tone perception within this speech area of 300 d. v. to 3,000 d. v., we must, from a utilitarian point of view, pronounce this child supremely deaf and unfit for re-education or restimulation by any form of sound amplification either of voice or instrument.

When, however, our diagram indicates that even at 120 dynes of sound intensity we secure a positive graph within the speech area in a deaf child, we feel that there may still be some stimulation or re-education developed that may prove of practical value.

5. *Tone Islands and Tone Gaps.* It has recently been asserted that there is no such thing as a tone-island or tone-gap. Thirty years ago Bezold, in an important monograph, claimed the presence of tone islands in various groups of congenitally deaf children tested with infinite pains by means of his continuous series of tuning forks. During the past thirty years we have substantiated this important observation by means of the Bezold series of forks and a specially-constructed harmonium of six octaves on the musical scale. Not only have we indicated the presence of tone-islands and tone-gaps by these functional tests, but by re-education by means of voice and musical stimulation these tone islands have apparently disappeared as indicated by subsequent tests. Whether such special stimulation as set forth in my work for over twenty-five years with the Acoustic Method has caused changes in the cochlea or whether there has been an intensive stimulation or e-education in the cortical auditory field, does not enter into this discussion.

Since the introduction of the audiometer, I have been puzzled by a peculiar incident in the audiogram for which I can find no other reasonable explanation than that of the tone-island, based on the Helmholz theory of the selective function of the ganglion cells and the hairs of Hensen in the organ of Corti. The number of cases graphed in suspected tone-islands is still comparatively small, but there seems, even in this small group, to be a fairly constant factor

leading to the conclusion that the sharp dips in the audiogram may be compared to the inability to hear certain pitched tuning forks or notes of the harmonium in the musical scale, nor can I account for the fact that this dip in the graph occurs most frequently in the pitch area of c^5 (4096 d. v.); this is just above the upper limit of hearing for the human voice and about the end of the middle whorl of the cochlea. In only one case thus far have I found a second dip in the graph of lesser hearing loss at about c^3 (1024 d. v.). These extreme and sharp dips in the audiogram must have some definite significance and give promise of interesting research.

Another explanation that may be offered for the sharp dip in the audiogram in the upper tonal range ($c,^5$ 4096 d. v.) may be found in pathological changes taking place on or about the fenestra rotunda. Thickening of the mucosa lining the cavum tympanum found in conjunction with exudative or suppurative processes or even the repair processes that follow a carefully exenterated tympanic cavity during radical mastoid operation, with consequent changes in the surface or substance of the membranous covering of the fenstra rotunda may prove to be one of the causative factors in this peculiar dip in the graph.

6. *Hearing Progress Record.* We have all been mindful of the inaccuracies in our records of functional tests of hearing. Whether we test by voice, whisper, watch or tuning fork, there are innumerable inaccuracies that make it difficult for us to follow the progress of our cases. The audiogram meets this difficulty definitely, for by means of repeated graphs we are in a position to determine definitely whether the hearing of the patient has improved or deteriorated and to what degree. Furthermore, we are in a position to intelligently discuss a patient's hearing defect with a brother-otologist elsewhere and to accompany our clinical case-record and observations with a diagram that will at all times present a definite status of the case, standardized and understood.

In conclusion, I think we are in a position to state that for accuracy, practicability, uniformity of results an potentialities, the audiometer is destined to supersede all previously recognized instruments in arriving at a definite status of the hearing function throughout its full range from normalcy to total deafness.

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PRIMARY DIPHTHERITIC OTITIS MEDIA.

Dr. J. Frank Friesen, Los Angeles.

Primary diphtheritic otitis media appears in the literature from time to time, but its occurrence is very rare.

In the standard textbooks on oto-laryngology, reference is made of a Klebs-Loeffler infection of the ear appearing in the course of a pharyngeal or nasal diphtheria, but a primary diphtheritic middle ear infection is scarcely mentioned.

Kerrison, in his work at the Willard Parker Hospital for infectious diseases, has made the observation that at least 5 per cent of all cases of diphtheria develop some form of acute tympanic disease. Duell states that it occurs in 10 per cent of all cases of diphtheria.

While only a small percentage of these aural complications are true diphtheria, the Klebs-Loeffler bacilla are usually associated with the streptococci and other organisms, that are responsible for the otitis.

Non-virulent diphtheria bacillus are frequently carried in the throats of healthy individuals and it has been found by various observers that a middle ear infection may be caused by a non-virulent Klebs-Loeffler infection.

Dr. Mellinger recently reported that he had seen eleven cases of non-virulent diphtheritic infections of the middle ear. He further reported that he had seen but one primary infection of the middle ear for which virulent diphtheria bacilli were responsible.

If aural discharge were cultured routinely by the attending physician, the Klebs-Loeffler organism would be found more frequently, especially the non-virulent type. The two cases reported here were primary diphtheritic middle ear infections without nasal or pharyngeal involvement. Their virulence was so marked, that they undoubtly would have proven fatal without the recognition of the nature of the infection, and the prompt and generous use of the diphtheritia antitoxin.

Report of cases: *Case 1:* Dr. R., a dentist by profession, married, age 34 years, was referred to me by Dr. Clarence R. Welfer in January, 1924.

Past History: He had measles and pneumonia at 15. During childhood a mild attack of pulmonary tuberculosis. In recent years there has been a chronic atrophic rhinitis.

Editor's Note: This mss. received in The Laryngoscope Office and accepted for publication Mar. 30, 1925.

Present Illness: Jan. 21, 1924, the patient reported at Dr. Welfer's office with a mild nasopharyngitis. Five days later while at a seaside cabin he felt twinges of pain in the left ear, which became severe during the night. Toward morning the ear discharged, giving him considerable relief.

The following day he was examined by Dr. Welfer. There was a profuse watery discharge from the left ear. The nose and throat were negative. Pulse 84, temperature 99,° heart, lungs, abdomen and extremities negative.

Jan. 28, two days after the acute onset, the patient began to feel ill, the aural discharge still being profuse, and of a watery character.

At this time his wife complained of a sore throat, with mild febrile symptoms. The examination showed inflamed tonsils with white spots. The culture was positive for the diphtheria bacillus. She was given 20,000 units of diphtheria antitoxin and the throat cleared very promptly.

Jan. 29, the patient with the ear infection appeared more toxic. Pulse 102, temperature 101.° blood pressure 90/70. The secretion from the ear was still of a serosanguinous character, containing flakes of white fibrin. There were patches of a white exudate in the canal at this time, which were removed with a swab. The nose, nasal vault and throat were examined thoroughly but no evidence of a diphtheritic exudate was found. On account of an atrophy in the nasal passages, it was very easy to make a thorough postnasal examination.

Cultures were taken from the ear, nose and throat. The ear was positive and the nose and throat negative for the diphtheria bacillus. Repeated cultures were taken with the same results. He was immediately given 20,000 units of diphtheria antitoxin subcutaneously.

The patient was rapidly failing. Pulse 114, temperature 102.° The fundus of the canal and the membrana tympani were covered with a white exudate. The discharge ceased without a recurrence of pain. There was a pronounced bulging of the membrana tympani, and it was decided to enlarge the small perforation to enlarge the opening. We noticed that the appearance of bulging was not due to a distention in the tympanic cavity, but an edema or thickening. By means of a sterile glass pipette, pushed through the opening in the membrana tympani, a specimen for culture was taken directly from the tympanic cavity. This also showed the presence of the diphtheria bacillus. The patient continued failing and his condition was critical; pulse 120, temperature 103,° blood pressure 60/40; 20,000 units of antitoxin were given intravenously, followed in 15 minutes

by a violent chill and convulsions, when cardiac stimulation became necessary. A few hours later 40,000 more units were given subcutaneously, preceded by 8 minims of adrenalin chlorid. There was a slight shaking and twitching, but no actual chill followed. After having received 80,000 units of antitoxin, his condition improved. The patient made a rapid recovery. The ear was dry in less than three weeks.

Case 2: Past History: Adult male, age 23 years. During childhood he had a postscarlatinal ear infection which discharged intermittently for several years. Since that time he has had no ear symptoms except when driving in the wind or swimming, there is an unusual sensitiveness.

Present Illness: Sunday, Aug. 24, 1924, while swimming, water entered the left ear, which caused a few days of pain and discomfort.

The following Sunday, he went swimming again and a few days later awakened with a sensation of fullness as though there was fluid in the ear. This was associated with malaise and headache.

He consulted Dr. Welfer and was referred to me for examination. There was a profuse watery discharge. An inspection of the canal revealed the absence of the membrana tympani, having been destroyed in the scarlatinal infection during childhood. The tympanic cavity did not show any exudate, but the profuse watery discharge aroused our suspicions on account of the experience with the previous case, and a culture was made to determine the organism. The following day the culture was reported positive for the diphtheria bacillus. At this time a white fibrous exudate covered the canal and the tympanic cavity. The patient felt ill and appeared toxic, pulse 96, temperature subnormal, blood pressure 90/70. He was given 40,000 units of antitoxin intramuscularly, a general collapse followed and stimulation became necessary.

Several hours later an additional 20,000 units were given. A temperature ranging from 99 to 100° followed for several days, after which his recovery was uneventful.

The outstanding features about these two cases were:

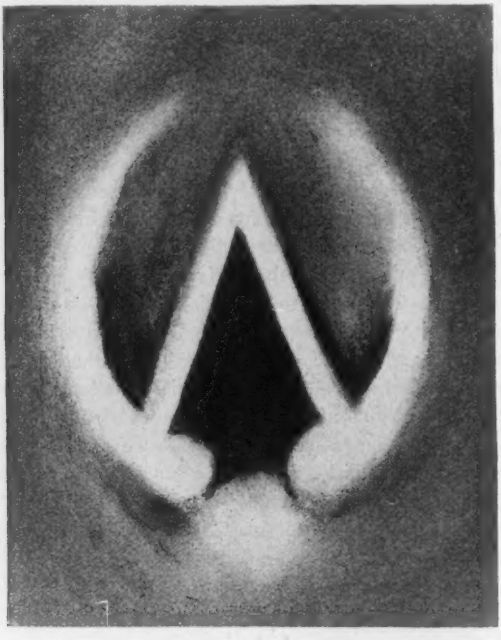
1. The extreme virulence of the infection.
2. The edema and swelling of the membrana tympani in the first case.
3. The profuse serosanguinous discharge throughout; later containing flakes of diphtheritic membrane.

711 Merritt Building.

A CASE OF ATRESIA OF VOCAL CORDS.

Dr. G. M. Van Poole, Honolulu, T. H.

S. T., age 18 years, came to see me on Feb. 5, 1925, for nasal trouble. The nasal cavities contained pus which could be seen coming from region of ostia of ethmoids, both sides. I noticed he was

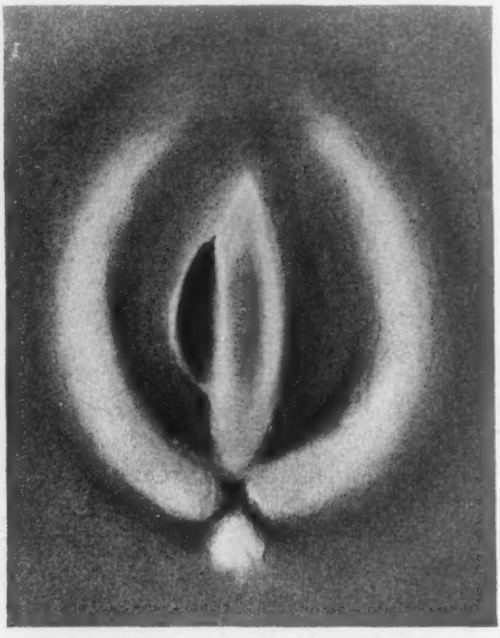


hoarse but had a fairly good voice. He said the hoarseness had existed from childhood and he had never had any soreness of throat that he could rememeber.

Upon examining throat with laryngeal mirror, I noticed that both vocal cords seemed to be to the left of the opening into the trachea.

Editor's Note: This mss. received in The Laryngoscope Office and accepted for publication Mar. 5, 1925.

I then cocainized his throat and made a thorough examination with Jackson's laryngoscope and found that both cords were united in their entirety with a slit-like opening to the right side of the cords. He breathed and phonated through this slit. I have tried to draw in Fig. 2 the way his throat looked when breathing naturally. Fig. 1



is a rough reproduction of an ordinary throat showing the normal chink of the glottis.

This case seems to be a congenital condition. There is no history of injury or disease that would cause such a deformity and the tissues look healthy with no old scars.

Young Building.

A BRONCHOSCOPIC OR ESOPHAGOSCOPIC SPECIMEN COLLECTOR.*

Dr. Louis H. Clerf, Philadelphia.

Collection of pus or other secretion from a bronchus or from the esophagus is often resorted to for bacteriological or chemical studies or for making a vaccine. At times the quantity is very small and none can be obtained at the proximal end of the ordinary aspirating

tube if it is of a large lumen. To obviate this the collector with a detachable reservoir was devised (Fig. 1). The collector can be attached to the negative pressure tube of an ordinary suction apparatus. When collection is completed the reservoir is detached and the specimen transferred to a sterile test tube. The entire apparatus can be sterilized by boiling.

*Read before the Philadelphia Laryngological Society, Oct. 16, 1924.

AMERICAN BOARD OF OTO-LARYNGOLOGY.

An examination was held by the American Board of Oto-Laryngology on May 26, 1925, at the Medico-Chirurgical Hospital, Philadelphia, with the following result:

Passed—137
Failed— 20

Total Examined—157

The next examination will be held at the University of Illinois School of Medicine on Oct. 19, 1925. Applications may be secured from the Secretary, Dr. H. W. Loeb, 1402 South Grand boulevard, St. Louis, Missouri.

THE NEW YORK ACADEMY OF MEDICINE.

SECTION ON LARYNGOLOGY AND RHINOLOGY.

Regular Meeting, December 29, 1924.

(Continued from June issue.)

DR. HELLER said he had been much interested in the case as he had seen five of the same type, four of the patients having sinus thrombosis. The fifth case had not been directly under his care, but Dr. Roth had asked him to see it. It was very similar to Dr. Harris' case: it started with a furuncle, which was incised and spread and the patient had a cellulitis of the face and was in the hospital three or four days, the whole condition lasting for a week or ten days. The abstinence from incision does not, however, lead to a solution, for the first case that he had seen was that of a young man from California who had tuberculosis and came East with a pimple in his nose, which was treated by his family physician with ordinary household remedies, no incision being made. Later the young man lost the sight of his eye and Dr. Heller was called in to see him, and found signs of sinus thrombosis; the eye beginning to obtrude and the sight was entirely gone; he died in about two days. The other three cases Dr. Heller thought had been incised, two of them certainly. Only that morning a man had come in with such a condition, which had not been incised but had been treated with something to give relief. Fortunately many of these cases are not serious, for furuncles of the nose are not uncommon, and it is not unusual for persons to pick them. However, it is an alarming and a very serious and tragic thing to have a patient come in with what appears to be an ordinary furuncle and yet die from it—and it is very important to know how to avoid such consquences.

DR. HERZIG stated that now was using acriviolet solutions exclusively in the treatment of nasal furuncles. The last three cases treated by him the solution of 1 to 200 acriviolet was applied upon cotton after penciling the furuncle with the solution first and giving the patient some of the solution home and having them apply it themselves every three hours. In this way he has been able to abort the last three cases. The time required was twenty-four to forty-eight hours. The method used was that of Dr. Joseph Abraham, who reported a considerable number of cases in which this drug was used. What had been said about the intravenous use of mercurochrome interested him very much as although he had no occasion to use same for a septicemia following furuncle, he he injected a case for Dr. Walscheid, whose patient had a streptococcus infection of the arm and he was going to amputate. In this case it prevented amputation. The second case that he had advised its use in answer to an inquiry by Dr. Neumann, who had a case of septic pneumonia of streptococcus origin (who will report same later). In both of these cases there was no doubt that the use of the mercurochrome saved their lives. The best way to use it is to *inject slowly*. He would not like to see it used in a case of acute endocarditis (of his). The men should not become discouraged if their first case dies, but continue to use it in appropriate cases.

DR. VOISLAWSKY said he had been much interested in what had been said by Dr. Heller and Dr. Herzig. He had himself seen five of these cases in the last three to five years, three of which proved fatal, and in two there was a terrible struggle to save the patients. The incisions were made practically as in Dr. Harris' case, and after a long siege they

got well. Dr. Heller had sounded the keynote. The patient comes in with a simple furuncle, a boil, and this condition develops and in a very short time the patient is apt to pass out. He had purposely added a report, though not in detail, of these five cases, as a note of warning for the protection of the nose and throat man who sees these cases. One seldom hears of lawsuits that are brought against colleagues until the suit is over, and often the records or reports are not searched prior to such a suit, and it was mainly on that account as well as to report the cases that he has spoken.

DR. PHELPS told of a case that had not been incised, the patient being moribund from meningitis when he saw him. He always incises them, but the thing that is most important in all infections is to do it with the least possible traumatism; squeezing is liable to be fatal, but if it can be done gently it is much the safest way; even the injection of cocain may traumatize or devitalize the tissues, but he would certainly incise them. If any aneshesia is found necessary, nitrous oxide is best.

DR. YANKAUER said it had been his custom to refrain from incision until the furuncle has pointed and not to extend the incision into the inflamed tissue, the idea being to remove the pus without exposing fresh tisues to infection. Recently he had had occasion to treat a patient for a furuncle which had penetrated the cartilage and was liable to rupture on the outside, and the patient was very anxious to avoid an external opening. She devised her own way of making wet applications, which was clever and very satisfactory; she made up the solution in a tumbler and stuck her nose into it; she kept this up all day until the abscess got well.

DR. WHITE thought the discussion was valuable in bringing out the desirability of avoiding the old-fashioned wide opening or the crucial incision.

DR. PHELPS agreed with Dr. Yankauer that one should wait until the furuncle points and then make the incision as gently and conservatively as possible, avoiding squeezing or pressure on the inflamed parts.

DR. HARRIS said that the subject was one which at first blush might seem so simple as hardly calling for discussion, yet perhaps there was nothing so apparently simple that had such possibilities of a serious termination. The very pertinent remarks of Dr. Voislawsky and Dr. Phelps had reinforced what had been brought out and were in line with the conclusions resulting from his investigations and inquiries among the general surgeons. The desire to go in and do a complete surgical operation is apt to be followed by dire results. Many cases do get through without untoward results; but there are many histories on record where active treatment has brought about a condition like this case, immediately followed in twenty-four or forty-eight hours by cellulitis, temperature, etc. When a furuncle is ripe, then open it with as little traumatism as possible and no expression at all. It is still better to attempt to abort it and prevent it from going on o where surgery is required.

A New Separator for the Nasal Crest in a Submucous Operation. Dr. A. J. Herzig.

I present for aproval and criticism a new instrument that I have devised for the separtion of the mucoperi-chondrium of the nasal crest during a submucous operation. Doubtless all of you have separated the mucoperi-chondrium from the crest and upon attempting to remove same have found some fibres of the mucoperi-chondrium adherent. Tieck's separator is the best that has been devised so far, but it only separates to the cut anterior edge of the cartilage. The instrument presented separates beyond the anterior cartilaginous incision and so insures a better separation as it separates further forward. The instrument may not be used until a piece of cartilage has been removed by means of the swivel knife or other instrument, as it is too wide to be introduced before. It may also be used to separate posteriorly. The shape of the

instrument prevents perforation of the mucoperichondrium. The instrument has a suitable handle, 4 inches long, a steel shaft 2½ inches long by .102 inch diameter, the distal end terminating in a hook formed by a returned bend of the shaft parallel horizontally with an open space ⅛ inch wide by $\frac{5}{16}$ inch (anteroposteriorly) long. The hook ends in a vertical arm ⅛ inch long by .091 inch diameter. They are made right and left.

A Device for Applying Radium in Carcinoma of the Oesophagus and Cardia. Dr. Sidney Yankauer.

DR. MARVIN JONES inquired whether the radium emanations were used in the form of seeds, and told of the laboratory in Buffalo where radium is used in that manner, putting in a number of seeds where radium is called for. At that time they thought the slough resulting was due to an infection, but since then they have come to feel that it is due to necrotic tissue.

DR. HARRIS replied that the radium used had the outward appearance of a radium needle, and was not the usual seeds, as he understood it. He had the impression that these burns from the emanations were of not infrequent occurrence, and that this was not a unique case. The doctors whom he had consulted thought that the burn was due to the strength employed. The case was not considered cured, by any means; the throat seemed to be all right, but there was still complete obstruction of the nose, and this extraordinary thing had taken place; instead of the soft tissue there was now this hard bony tissue in the nose. The macroscopic picture had changed since a year and a half. It had been his purpose to go on further with radium until this new appearance took place in the pharynx. In the meantime, the child looked perfectly well, and had no enlarged glands, the blood count was normal, and there was no leucocytosis, but nevertheless the internists made the diagnosis of Hodgkin's disease.

DR. G. A. ROBINSON: Radium is employed for two purposes; one for the complete destruction of tissue, which is termed the caustic effect, and, the other purpose is for growth restraint, and is used when the growth is too large to permit of complete disintegration by the caustic method. In this instance there was overaction and destruction of tissue, the dosage being approximately four times that of a growth restraint dose, which would produce only cell change without necrosis.

Radium emanation is ordinarily used in the form of bare glass tubes, which are inserted into the tumor by means of a trochar needle, and are allowed to remain *in situ*. However, the emanation or Radon may be screened with various thicknesses of metal as is the radium element. The screenage of radium needles is from 0.2 to 0.4 m.m. of platinum or nickel-steel and cuts off most of the beta rays, which are irritating, the hard beta and gamma rays being employed. One millicurie of Radon is equivalent to 133 mc. hrs.

A New Tonsil Irrigator. Dr. Sidney Yankauer.

DISCUSSION.

DR. HELLER wanted to know if this irrigations were to be used in children as well as adults. He found that pain was largely due to allowing throat to become dry, and then the muscular effort on this dry throat caused a great deal of pain and that was partially overcome by giving the patient quantities to eat. Dr. Heller said that he had never given irrigations, mainly because he found that the family could not handle them. For the last two years he has used a gargle made of equal parts of aspirin, sodium bicarbonate and powdered acacia, peppermint oil, 10 drops to ounce, a teaspoonful dissolved in a glass of water, and directing the patient to swallow half of it. That gives the patient 5 grs. of aspirin every two hours and affords great relief. Dr. Heller said he was very glad to hear what Dr. Yankauer had said about the irrigation of throats and believed this new instrument would facilitate irrigations materially.

DR. JONES said he was interested in what Dr. Heller had said about the gargle, for he had a preparation of aspirin and soda bicarbonate combined in a tablet under the name of the Post-Graduate Hospital Gargle.

DR. PHELPS said that Dr. Yankauer had emphasized the fact that he used only plain water for the irrigation, no salt or soda. He had himself employed irrigations but always with salt or soda added.

DR. HARRIS said it seemed a far cry from irrigation to spray, and then told of a physician he had met during the summer who said that he had lost patience with his patients' complaints of pain. He had his own tonsils taken out later and used a spray containing aspirin, was back in his office the next day, and really had no pain at all. One of his house men had been keeping a record of cases treated with aspirin spray, and stated that fifty to seventy-five cases had been so treated, with uniformly good results, little pain and dysphagia. It was questionable whether irrigation would produce the same good results in so convenient a way as a spray or gargle. Dr. Harris said that he uses a spray in his own cases, but that he was much interested in Dr. Yankauer's remarks, for it was certainly most unsatisfactory to see a patient the day following operation and hear his complaints of suffering.

DR. WHITE expressed pleasure that this subject had developed, for it is getting to be a rather common practice among the laity, after the tonsils are removed, to get aspirin tablets from the druggist. He had seen cases of near collapse apparently from the use of aspirin by patients who said they had taken a tablet "once in a while" during the day.

DR. HELLER, commenting on Dr. White's remark, said that all aspirin is not the same, and that he always specified Squibb's product when ordering it. Some of the aspirin on the market it not safe to take, and that was probably what was the matter in the cases reported, not the aspirin.

DR. YANKAUER said he did not employ irrigation with children for it was almost impossible to control them, but used it with adults, who could irrigate the throat as often as it hurt them; they reported that the relief of the pain following the hot irrigation was very satisfactory. In that way he gets along without the use of drugs. He had used aspirin, knew that it had a very decided local anesthetic effect, but he had an idea that it delayed the healing of the wound. He uses plain water because he doesn't see any advantage of either salt or bicarbonate of soda in the mouth. The heat and the getting rid of the mechanical particles of food aws the main thing desired. Besides the relief of pain there was another decided advantage in the irrigation treatment: it usually requires about two weeks for the parts to heal—there is an exudate in the throat and an open sore, and there is danger of a late secondary hemorrhage ,etc., so that the more quickly the parts are healed the better for the patient. This can be accomplished in two-thirds of the time with hot irrigations.

SECTION ON OTOLOGY.

January 9, 1925.

Recently Observed Cases of Intracranial Complications Following Acute and Chronic Middle Ear Infections. These cases of otitic complications are presented from the service of Dr. I. Friesner, Mount Sinai Hospital.

1. Case of Brain Abscess of Otitic Origin. Cured. Dr. S. Rosen.

Case 1. John M., age 51 years; admitted June 21, 1922; discharged Aug. 4, 1922.

Patient admitted to Mount Sinai Hospital, Neurological Service, with history of acute purulent otitis media ten weeks before. The drum was

incised at that time and the ear discharged continuously until ten days before admission, when the ear became dry. For seven weeks before admission the chief complain of the patient was headache localized to the right side. About the time the ear stopped discharging the patient vomited and became unconscious for three days. No convulsions. On admission the patient was facetious at times, dull and apathic. Fundi negative. No elevation of temperature. The right tympanum showed a loss of lustre but was otherwise negative. All the landmarks were visible. No evidence of mastoiditis.

The spinal fluid came out under slightly increased pressure, was clear and contained 300 cells; polys and lymphacytes in equal numbers.

The neurological signs of intracranial suppuration became more evident; there was increasing stupor; left facial weakness, left ankle clonus and left Babinski. On June 27, six days after admission, the right temporosphenoidal lobe was explored by Dr. Friesner through a trephine opening. A large temporosphenoidal abscess was found and drained. The patient made an uneventful recovery, was discharged on Aug. 4, 1922, and has been well ever since.

Fully resolved middle ear, development of a right temporosphenoidal abscess. Patient well two and one-half years since operation.

2. **Case of Uncomplicated Mastoiditis with Optic Neuritis.** Dr. S. Rosen.

Case 2. Harold G., age 12 years; admitted Sept. 3, 1924; discharged Sept. 18, 1924.

Patient admitted to Mount Sinai Hospital with history of bilateral earache for ten days after swimming. One week before admission a double paracentesis was done, the ears discharging since then. On admission the patient presented a rather unusual clinical picture. He was dull, torpid, responded slowly and was irritable. Temperature 99.5.° pulse 60. Lumbar puncture negative.

Right ear: Thin serous discharge, moderate in amount, drum thickened. Landmarks not visible; hearing markedly impaired; slight tenderness over tip and antrum.

Left ear: Similar to findings.

Blood count: 9,000; 62 per cent polys.

The fundi showed a beginning optic neuritis. The mental condition continued; temperature remained below 100° throughout and the bracycardia, 50/60 persisted. Three days after admission the signs of mastoiditis became definite and a bilateral simple mastoidectomy was done by Dr. Maybaum. Soon after the operation the mentality of the patient became normal and he made an uncomplicated recovery except for the persistence of the bilateral optic neuritis for eight weeks.

The bacteriology of the mastoids was pneumococcus-indeterminate type.

Comment: History of bilateral mastoiditis due to pneumococcus infection with pronounced mental disturbance, low temperature, bracycardia, bilateral optic neuritis are the salient points in this case. Clinically before operation the picture was that of a streptococcus mucosus mastoiditis with intracranial complication. Optic neuritis in a case of uncomplicated mastoiditis is an unusual finding.

3. **Case of Sinus Thrombosis.** Dr. S. Rosen.

Case 3. Ida S., age 10 years; admitted Mar. 3, 1924; discharged Apr. 11, 1924.

Patient was admitted to Mount Sinai Hospital with history of pain in right ear for ten days and discharge for four days following a spontaneous perforation of the right drum. After two days in the hospital the signs and symptoms of acute mastoiditis became definite and a simple mastoidectomy was done. The cells were broken down, granulations and pus present. The sinus plate was intact and apparently normal. The usual postoperative rise of temperature to 104° took place, but instead of declining, the fever remained high, between 102 and 104.5° for eight days. The only physical findings to account for this was a well marked cellulitis of the scalp, not red, not particularly tender but

with marked pitting. The child did not look sick, sat up in bed, was playful, ate well and slept well. However, during the ensuing week, the ranges of temperature were much greater being 99° in the morning and 105° in the evening, at one time reaching 107,° and with this a recession in the cellulitis of the scalp. The hemoglobin was steadily decreasing, being 80 per cent after the simple mastoidectomy, until on Mar. 22 it was 66 per cent, with persistently negative blood cultures. A sinus exploration was evidently indicated. Blood counts varied between 15-20,000; 75 per cent polys. Jugular ligation and sinus operation was done by Dr. Maybaum. The apparently healthy sinus plate was removed, and a gush of pus was seen coming from the sinus; a purulent thrombus was removed, free bleeding being obtained from bulb and torcular ends. Following the operation 300 c.c. of blood was given the patient by the Unger method. The temperature gradually returned to normal. One week after operation temperature reached 101° and blood culture revealed hemolytic streptococci for the first time. However, the general condition steadily improved. Following this the temperature remained normal and the blood cultures were negative. Patient discharged well.

Pathological report: Purulent thrombus, hemolytic streptococcus.

Comment: The interesting feature in this case of sinus thrombosis is the persistent negative blood cultures during the disease, and the positive blood culture one week after operation. Recovery without further operation.

4. **Case of Sinus Thrombosis Complicating Acute Exacerbation of Chronic Middle Ear Suppuration Due to Bacillus Proteus.** Dr. J. L. Maybaum.

Case 4. Hyman R., age 18 years; admitted Dec. 22, 1922; discharged Feb. 8, 1923; well; uncomplicated recovery.

Patient admitted to Mount Sinai Hospital with a history of chronic discharging ear of two years and an acute exacerbation of three days duration.

On the following day, Dec. 23, a radical mastoidectomy was done and a huge perisinus abscess involving almost the entire lateral sinus in its mastoid course was found. There was a cholesteatoma in the antral region. Culture of mastoid showed streptococcus overgrown by Gram Negative Bacillus. The patient ran an uncomplicated postoperative course for forty-eight hours, the temperature gradually receded from 102.4° on admission to 99.°

Suddenly the temperature rose to 104° and the patient had a chill lasting 4 minutes. This was repeated on the following day, after which the temperature remained down for four days. Blood cultures were repeatedly negative. Then the temperature rose again critically and became septic with repeated chills for three days.

On Jan. 3, the jugular was ligated and the sinus explored by Dr. Maybaum. An obturating purulent thrombus was found.

Pathological report: Inflamed sinus wall with purulent exudate.

Culture (thrombus): Pure culture of bacillus proteus.

Comment: This case is of interest, as sinus thrombosis in which the infecting organism is B. Proteus is extremely rare. B. Proteus is usually considered to be of low virulence; it may appear in the blood at the end of an exhausting illness by invasion from the intestines. When found in chronic suppurative otitis media of long standing, it is probably a secondary invader after the original invader has disappeared. Green and exceedingly foul-smelling pus is characteristic of these cases.

In the case reported, the B. Proteus while present in pure culture in the purulent thrombus removed from the sinus, was not recovered from the blood. The few cases of bacteremia due to B. Proteus have all been fatal. Dr. Kernon, a few years ago, reported before this Section two interesting cases of this kind.

5. **An Unusual Case of Sinus Thrombosis (Primary Bulb).** Dr. J. L. Maybaum.

Case 5. Adolph C., age 15 years; admitted Jan. 19, 1924; discharged Apr. 4, 1924.

Patient admitted to Mount Sinai Hospital complaining of earache, drowsiness and buzzing in the right ear for one week. Three days before admission there was a spontaneous, painless perforation of the right drum with medorate purulent discharge. The boy looked sick and had a temperature of 105.4.° There was a slight thin purulent nonpulsating discharge from an anterior perforation, drum being flat, landmarks visible; no sagging, hearing moderately impaired; the middle ear evidently resolving. There were glands palpable at the angle of the right jaw. Blood count 22,000 with 88 per cent polys. Fundi negative.

At 2:30 p. m., the following day, the patient had a chill, the temperature rising to 106.2,° and it was decided to explore the sinus, there being nothing else to account for the clinical course. A shower of subscrepitant rales appeared in both chests anteriorly. The operation was deferred in as much as it was thought that the patient had developed a pneumonia. The blood culture taken on admission was still negative. On the morning of the third day of the patient's admission to the hospital it was noted that there was a beginning optic neuritis, bilateral; the blood culture of the second day was reported positive hemolytic streptococcus. The signs in the chest remain the same; the clinical picture was not one of pneumonia. On Jan. 22, three days after admission, the patient was operated on by Dr. Maybaum. The mastoid was apparently free of pathology. The sinus plate was intact. When the sinus was uncovered pus was seen exuding from it. The jugular was ligated. The pus yielded an hemolytic streptococci.

The temperature remains septic after operation. The chest signs continued diffuse, occasionally the patient spat up blood-tinged sputum. For the next four weeks the temperature remained high, the chest signs persisted and there developed a metastatic arthritis of the left shoulder which subsided, and a large deep abscess of the buttock was opened and drained. The blood culture was positive only once during the interval. Gradually the temperature came down to normal. The chest signs disappeared. The general condition improved, and the patient was sent to the country. He returned three weeks later, well.

Comment: The predominant feature of this case of primary jugular bulb thrombosis was the occurrence of a severe, metastatic, bilateral pulmonary involvement.

6. **Case of Acute Mastoiditis with Bacteremia of Unassignable Cause.** Dr. J. L. Maybaum.

Case 6. Harry Z., admitted Nov. 1, 1924; discharged Dec. 29, 1924.

Patient admitted to Mount Sinai Hospital with a history of pain in the left ear and discharge for six days after paracentesis. After one week's observation the signs of acute mastoiditis became definite and a simple mastoidectomy was done. Blood count 18,000; polys. 75 per cent. Granulations and pus were found in the mastoid. Five hours after operation the patient had a chill lasting five minutes, with a rise of temperature to 104.° Blood culture taken was negative. On the following morning beginning cellulitis of the neck below the mastoid wound was noted. For the following five days the temperature gradually receded in step-like manner to 100° and the cellulitis had apparently disappeared, but deep pressure on the neck caused a gush of pus through the lower angle of the mastoid wound. There was then a sharp rise to 105,° and blood culture at this time revealed 144 colonies, hemolytic streptococci. On the following day the temperature again reached 104° from 100,° and the blood culture showed only one colony of hemolytic streptococcus. On Nov. 17, crucial incisions were made in the neck by Dr. A. V. Moschowitz, a great deal of pus, muscle and facial necrosis being present. No gross evidence of phlebitis. The next day the tem-

perature was not so high and the blood culture revealed one colony of hemoyltic streptococcus. During the four succeeding days with temperature ranging from 100° to 103° daily, the blood cultures were sterile. The temperature then began to oscillate between 99° and 102° daily, with a reappearance of streptococci in the blood, from one to three colonies being present. With the neck infection clean and no local evidence to account for the persistent bacteremia, it was decided to uncover the sinus and explore it if necessary. Accordingly on Dec. 3, the sinus and its mastoid course was uncovered and appeared normal. Nothing further was done. Two days later the temperature reached 101° and the hemolytic streptococci were present in glucose bouillon flask only. The general condition of the patient was excellent, the neck wounds were healing, the temperature came to normal and remained so, the bacteremia ceased and the patient was discharged well.

Comment: The occurrence of a neck infection secondary to simple mastoidectomy with development of a bacteremia are the interesting features in this case. Bacteremia was due either to a sinus thrombosis which healed spontaneously, or the result of thrombotic process in the smaller veins in the neck.

7. **Case of Sinus Thrombosis Complicated by Metastatic Emypema with Sontaneous Recovery.** Dr. J. L. Maybaum.

Case 7. Irving H., age 10 years; admitted May 26, 1924; discharged July 9, 1924.

Patient admitted to Mount Sinai Hospital with a discharging ear of two weeks duration; severe frontal headache for three days. The right drum was flat, moderate middle ear discharge from a postinferior perforation. No sagging; spinal fluid negative. During the three days following his admission the boy was running a septic temperature. Blood culture taken on the first day was reported positive, hemolytic streptococcus. Jugular, mastoid and sinus operation by Dr. Maybaum. The jugular was ligated. The mastoid was found to be diseased, free pus being present. The lateral sinus contained a purulent thrombus. There was no bleeding from the torcular and bulb ends. Although the condition of the patient improved after operation, the septic temperature and the bacteremia continued for a week. Thick purulent discharge could be squeezed from the neck through the bulb into the mastoid cavity. The neck wound was revised and jugular resected for about 1½ inches. Complete exenteration of the sigmoid sinus to the bulb was then done. Jugular bulb packed, wound Dakinized. The bacteremia disappeared after this. Following this the patient complained of pain in the right chest. The fever continued and signs of an effusion appeared in the right chest.

X-ray of chest showed a right-sided encapsulated empyema.

On June 26, about three weeks after operation, the patient had a paroxysmal coughing spell, expectorated about two ounces of green odorless pus, following which the chest signs disappeared. The temperature came down and the patient made a rapid recovery.

Comment: The interesting feature of this case of sinus thrombus was the development of a metastatic empyema, which ruptured into a bronchus with spontaneous cure.

8. **Case of Lateral Sinus Thrombosis Complicated by Metastatic Lung Abscess with Spontaneous Recovery.** Dr. J. L. Maybaum.

Case 8. Henry S., age 32 years; admitted July 5, 1920; discharged Sept. 9, 1920.

Patient admitted to Mount Sinai Hospital on the afternoon of July 5 with a chronic discharging ear of twenty years duration and an acute exacerbation of four days duration. The patient had two shaking chills before admission, with high temperature. Blood culture negative. The following morning a radical mastoidectomy, jugular ligation, sinus and bulb operation were done by Dr. Friesner. The mastoid was badly dis-

eased, the sinus and bulb being the seat of extensive purulent thrombosis.

Four days postoperative the temperature oscillated between 100° and 102.° On the fifth day postoperative, the patient had a chill with a rise of temperature to 104.2,° complaining of a sticking pain in the left chest. X-ray of chest at this time showed a pneumonia of the left lower lobe, although the physical signs were not typical, there being dullness, bronchovesicular breathing and occasional moist rales. These physical signs persisted for several weeks when the patient coughed up about two cupsful of purulent mucoid, odorless secretion daily.

From the onset of the pulmonary symptoms and signs up to the time of discharge from the hospital, the patient ran a temperature from 100° in the morning to 102-103° in the evening. Blood cultures still negative. On Aug. 2, X-ray of chest showed an abscess in the left lower lobe; a circular cavity 1½ inches in diameter with a fluid level.

Sept. 2, bronchoscopy showed a large amount of purulent secretion coming from the left lower lobe branch.

The patient was discharged Sept. 9, with the mastoid wound almost completely healed. Still coughing up large amounts of pus. He was sent to the country by the Social Service Department, where the pulmonary suppuration healed spontaneously and completely after a few months.

Comment: The interesting feature in this case of sinus thrombosis is the absence of positive blood cultures throughout, and development of a pulmonary abscess, metastatic, which healed spontaneously.

9. **Case of Primary Jugular Bulb Thrombosis.** Dr. J. L. Maybaum.

Case 9. Anna H., age 7 years; admitted Feb. 1, 1923; discharged Sept. 14, 1923.

Patient admitted to the Pediatric Service of Mount Sinai Hospital with history of severe pains in both legs for the past four days. Eleven days before admission the patient had pain in the right ear. The mother was assured by physician that there was nothing abnormal with the ear. The pain continued for a few days and disappeared; never any discharge. Temperature on admission, 103.2.° The physical examination revealed exquisite pain on pressure over both hips, especially the left, and over the right tarsus. The right typanum was somewhat thickened; landmarks present; no bulging and no evidence of mastoid disease. Blood culture taken at this time showed hemolytic streptococcus. The temperature remained between 102-104,° and on Feb. 5 a huge pyarthrosis of the left hip was opened and drained, hemolytic streptococci being recovered from this focus.

After this operation the temperature ranges were not so high for a few days, but again oscillated between 101° and 103,° until on Feb. 11 a pyarthrosis of the right ankle was opened and drained, yielding the same organism. Whereas the bacteremia was present persistently up to this point, the blood after this operation apparently became sterile for five weeks, during which time there was marked improvement in the general condition, except that there developed marked lumbar tenderness, especially on the right side. The right kidney became enlarged and hyaline granular casts, W. B. C. and R. B. C. appeared in the urine in great numbers. Exploration of the right kidney for subcortical abscess was negative.

On Mar 19, the temperature suddenly rose to 104.8° and with this there appeared an adenitis at the angle of the right jaw. Blood culture revealed the reappearance of hemolytic streptococci. The temperature oscillated between 100-105° for a few days. The fundi showed a bilateral choked disc O. D. 3 D, O. S. 6 D. The glands increased in size and the bacteremia became pronounced, 160 colonies per c.c. In view of the bacteremia, eye findings, cervical adenitis (angle of jaw) in the presence of normal middle ears, a diagnosis of primary jugular bulb thrombosis was made. There was no evidence of any suppuration in the middle ear at any time. On Mar. 22, the jugular right was ligated by

Dr. Maybaum, the general condition of the patient not permitting further surgical interference.

On Mar. 24, two days later, the right lateral sinus and bulb were explored by Dr. Friesner. The mastoid, the antrum and sinus plate were normal. The sinus was exposed in its mastoid course and for two inches behind the knee. On opening the sinus, an escape of pus was seen from bulb to torcular. No free bleeding. The blood culture, three hours after operation, showed 20 colonies per c.c., and forty-eight hours after operation the blood culture was sterile and remained so. The temperature came down promptly and remained normal. The papilledema gradually receded until on discharge there was a retrogressive neuritis. Patient discharged Sept. 14 with healed mastoid and cervical scar.

RESUME OF SINUS THROMBOSIS CASES.

Of these seven cases of sinus thrombosis: Six were operated upon with findings of purulent thrombus in the sinus.

One case (6) recovered without jugular or sinus operation. The bacteremia in this case may have been due to a thrombotic process in the smaller veins of the neck or the case was one of spontaneous recovery with sinus thrombosis.

1. Three cases (5, 7, 9) of the six cases operated upon had a positive culture report, streptococcus hemolyticus, before operation.

2. Three cases (3, 4, 8) were operated upon without waiting for culture report. 1. One of these (Case 3) had a positive culture for the first time one week after operation; negative thereafter. 2. One (case 4) had negative cultures throughout but purulent thrombus from the lateral sinus showed bacillus proteus. 3. One (case 8) negative blood culture throghout.

Purulent thrombus was found in cases operated upon. Five showed streptococcus hemolyticus. One case, bacillus proteus.

Five cases (3, 5, 6, 7, 9) complicated acute middle ear infections. Two cases (5, 9) were cases of primary jugular bulb thrombosis.

Two (4 and 8) cases followed acute exacerbation of chronic middle ear suppuration.

Three (5, 7, 8) had serious metastatic pulmonary complications.

One case (9) had metatasis in the joints and muscles.

Ligation of jugular vein was done in all of the cases. In one of these cases (7) a revision of the neck wound and jugular resection had to be done. Simple incision and evacuation of localized purulent collection may suffice in such cases.

Three cases (7, 8, 9), a complete exenteration of the sinus to the jugular bulb was done.

Two cases (5, 9) fundi findings were an important aid in determining the question of operative interference.

DISCUSSION.

Dr. Maybaum said that Dr. Rosen's remarks as to the value of blood cultures holds true. In the average case, unless the picture were absolutely definite and urgent, one would hardly operated without waiting for a blood culture report. Repeated negative culture findings do not necessarily exclude the diagnosis of sinus thrombosis, as instanced by a number of cases reported this evening. One must, however, at all times be guided by the clinical picture. The first case had a definite picture of a sinus thrombosis, and may have had a sinus thrombosis spontaneously cured; the entire aspect of the patient, the change in the blood findings from time to time, favored an opinion of continued improvement; it was decided not to operate, although at one time it was thought necessary. As a checkup after a sinus operation, a number of blood cultures is invaluable.

Dr. Barnert had brought out a very important point: the necessity for routine examination of the fundi in otitic cases with possible complications. As a routine at Mount Sinai Hospital, we now examine the fundi repeatedly to note early changes in the hopes of reaching earlier diagnosis in doubtful cases. Optic neuritis is present in 10 to 15 per

cent of cases of sinus thrombosis; the proportion may be higher if these examinations are frequently done by the otologist, checked up by the Ophthalmologist. In two of the cases reported this evening, positive fundus findings were an important factor in deciding upon the question of operation.

Dr. Schiller referred to a case of primary bulb thrombosis occurring in an adult; such cases are rare, they usually occur in young children. With practically negative ear history and findings, these cases are often extremely difficult to diagnose. In one of the cases reported, the bacteremia, eye findings, enlarged cervical glands at angle of jaw, even in the absence of ear findings, made the diagnosis of primary jugular bulb thrombosis certain.

Dr. Maybaum remarked that it was a relief for once to attend a meeting of this kind without the usual wrangling over the question of the advantages of jugular resection or ligation. The case cited by Dr. Scheer, of marked changes in the jugular vein, must have been quite advanced. If the vein shows macroscopic changes of disease, a resection is of course indicated. We find that a low ligation answers the purpose, only in rarest instances is it necessary to resect later.

Facial Paralysis, Perisinus Abscess and Mastoiditis Within Forty-eight Hours After an Acute Otitis Media. Dr. I. M. Heller.

Myron R., age 1½ years, had never been ill until the early hours of Friday, Dec. 12, 1924, when he awoke with fever and pain in his right ear. His family physician, Dr. Steinman, saw him shortly after and aside from the aforenamed symptoms could find nothing.

I saw him at three that afternoon and was told that he had rested easier for the previous hour and that the ear was discharging slightly. Temperature was 103.° From the right canal came a small amount of purulent material and the posterior portion of the drum was red and bulging. There was no mastoid tenderness or anything to suggest an abnormal case. The left drum was also inflamed, but not bulging.

As the perforation in the right drum was small, I did the usual paracentesis, which was followed by a free flow of pus. Left membrane was also incised but only bloody serum resulted. Temperature fell to 101° and patient had a fair night. The next evening, the doctor was told by the mother that the face seemed out of shape. On Sunday afternoon, forty-eight hours after paracentesiss, I again saw him and in consultation with Dr. Murray Bass, a pediatrician, and Dr. Steinman. There was complete paralysis of the right side of face. Temperature 104,° left ear dry, right ear, discharging moderately, slight sagging of postsuperior wall and distinct tenderness over mastoid process. My reason for having in a children's specialist was to rule out the possibility of a polyencephalitis or other intracranial condition. After a thorough examination, Dr. Bass came to the conclusion that, although he had never seen a case of facial palsy follow so close upon the heels of an acute otitis media, he could come to no other conclusion.

Patient was taken to Lebanon Hospital at once and operated upon in an hour. On uncovering the cortex a small amount of pus was released. Tip was undeveloped and as was to be suspected, there was little destruction of bone cells. Working posteriorly, at the knee of the sinus, we came upon a dram of thick green pus under considerable pressure and on cleaning this away, found the lateral sinus bare about one-third of an inch. Antrum contained a small amount of pus, which proved on culture to be streptococcus hemolyticus. There was nothing further unusual about the operation and it was finished in the regular way.

Temperature fell to 100° that night and then to normal in a few days. Paralysis improved somewhat so that he could close his eye completely, but now after four weeks corner of mouth still sags and nasolabial fold is quite obliterated.

The early appearance of the paresis can be accounted for only by a dehiscence in the bone covering the facial nerve somewhere in its course

through the petrous bone. Whether or not there has been a destruction of the nerve, a true neuritis by direct extension, or simply pressure from an edema of the sheath, is difficult to determine. While the paralysis has improved slightly, it is not sufficient to be positive that the nerve has not been injured irreparably. There is, of course, still hope the nerve will regenerate, particularly since the branch to the eye has shown improvement.

DR. BLACKWELL, referring to Dr. Heller's case of facial paralysis, said that in connection with acute inflammatory conditions of the middle ear it is sometimes characteristic of certain epidemics of coryza that there will be facial palsy connected with catarrhal condition of the middle ear, etc., and in order to determine whether or not it is a case of middle ear palsy it is customary to test the side of the tongue for its taste sensation, and if that side is involved it is generally assumed that the palsy has taken place in the middle ear and the mastoid is not affected. Of course, in this instance, since Dr. Heller reported that the mastoid was affected, the disease was probably connected with the disease in the bone.

DR. A. N. SCHILLER: A case from Dr. Dougherty's service at City Hospital, child age 10 years, with a mental picture suspicious of meningeal infection. The temperature was more than one could explain by an acute mastoid. On operating, a negative mastoid was found, and seeking further the sinus was exposed and found to be normal in color, but with no pulsation at all. Here was a case with a negative mastoid and a macroscopically normal sinus, with thrombosis in the bulb.

Another patient was admitted to the Beth Israel Hospital in Dr. Kopetsky's service, with the same mental picture. The history was that of a young man of 19 years, with an otorrhea of ten days duration, but with a high temperature, which could not be explained by the otological findings. Operation for acute mastoid revealed a hard sclerosed mastoid with no pus present. The anterior wall of the sinus was exposed, showing a normal sinus plate. The patient was put back to bed and ran an atypical sinus temperature; the blood culture was negative, but the temperature caused suspicion. Later the case was reoperated upon and a sinus thrombosis was found extending way back to the torcula. Dr Kopetsky's case still has some choked disc.

DR. CYRIL BARNERT said that eye findings in mastoiditis and its complications are uncommon statistically and comparatively, but when found are of extreme importance and are often the contributing factor which makes operative interference necessary. It is essential that every case of mastoiditis or impending mastoiditis should have a careful examination of the fundi oculi. This is important for two reasons: first, to discover the presence of any abnormality indicating an active process; and, second, for the careful charting of any aberrations from the normal physiological findings. The normal disc may be slightly blurred, there may or may not be a cupping of the disc, there may be opacities which make it difficult to get a good picture. If these are noted on the chart, anyone making a second examination of the fundus, and armed with the previous status, could make a better diagnosis of the conditions found. The points one looks for in the fundus are evidences of beginning optic neuritis or beginning papillary stasis or edema, and these are indicated by increased hyperemia of the surface of the disc, blurring of outline due to edema or exudate, and tendency for the physiological cup to fill up with exudate, increased tortuosity of the veins, together with a little elevation of the disc surface, possibly hemorrhages, and in case of papillary edema increased elevation, together with a marked contraction of the arteries as compared with the calibres of the veins. The cases that had been shown were typical, and showed a higher average of eye findings than one might expect, owing to the fact that at the Mount Sinai Hospital fundus examinations are made as a routine. In one instance there was a little slipup and the diagnosis was in doubt, and it was only after the temperature having

been low for several days showed a sudden rise accompanied with a chill, suggesting to the staff that she might be developing a cavernous sinus thrombosis, that an eye examination was requested. He made a special evening visit to the hospital, discovered an advanced bilateral papilledema, 3 diopters in the right and 6 diopters in the left eye, and a note was placed on the chart suggesting that it was undoubtedly due to primary bulb thrombosis or brain abscess. The otologists were called and tied off the jugular that same evening. That was the case of the girl admitted with streptococcus hemolyticus in the blood and multiple abscesses in the joints.

The case of the boy who had a bilateral optic neuritis presented some rather unusual features so far as operative procedures and convalescence were concerned. There was no definite evidence of any intracranial complications. Dr. Friesner believes that changes in the background invariably indicate an intracranial complication, and that the papilledema in these circumstances almost always predicates a sinus or bulb thrombosis, and Dr. Barnert's experience confirms this finding. There was a definite story of torpor and irritability, and in spite of the fact that nothing was found at operation, or nothing to indicate a further operation beyond the mastoid. Dr. Barnert said he believed that this was also a case of intracranial complication. There are cases on record of optic neuritis from focal infections, and perhaps that was the case in this patient, but it has been made a working rule that in the presence of an acute suppurative mastoiditis with optic neuritis, or papilledema we are pretty sure to be dealing with intracranial comcomplications.

Another case was sent in two years ago by Dr. Willy Rieser with a diagnosis of lateral sinus thrombosis and double choked disc of 4 diopters; operation and recovery.

Dr. Barnert said he was not quite sure as to the way in which a papilledema occurs in lateral sinus thrombosis. It is certainly not the same type of papilledema as one due to increased intracranial pressure *per se*, but rather the type one sees in nasal accessory sinus disease and in focal infections of other types.

Dr. H. M. Scheer said it was interesting to note that in the entire series of cases presented by Dr. Maybaum and Dr. Rosen there was not one in which the clot was found deeper than the jugular bulb; in most of them the clot was above that, and in two it was in the jugular bulb itself, particularly when a number of these cases had been of such long standing, several weeks or a month or more. At the Manhattan Eye and Ear Hospital, within the past year, a young Italian girl came into the clinic who had been sick for a month with earache, for which she had been treated by someone outside. Not being relieved, she came to the clinic. She seemed very sick and toxic, and a diagnosis of acute mastoiditis was made. No further laboratory examinations could be made at the time, and she was immediately taken up to the operating room for a mastoidectomy, which revealed complete destruction of the process, with pathological sinus and perisinus abscess. An obliterating clot extending to 2 inches behind the knee of the sinus was removed before free bleeding could be obtained. This was done after the neck incision was made to tie the jugular vein. This was done after the neck the vein was found to be almost as stiff as a pencil and it could be easily lifted out of its sheath, extending down into the chest, so that the incision had to be extended down to the clavicle. This stiff jugular vein was ligated and resected at the clavicle; there was a severe phlebitis and clot throughout, down to where it was resected, and unquestionably further into the chest. The patient developed a right-sided lung involvement, but rallied along with transfusions and treatment by the internists for four weeks before she finally died. It was very interesting to see how she had gone along outside for four weeks, without anyone suspecting that she had anything more than an acute ear and before deciding that she needed hospital care.

DR. HELLER thought that this series of cases brought out one or two very interesting points. Of the seven cases, only three showed a positive blood culture before operation, and one a week afterward. We have been inclined to rely too much on the presence of a positive blood culture. Of course it is very advantageous to know that there is a positive blood culture, but sometimes we wait too long, and with out present methods of operating it is often safer when in doubt to go in and uncover the sinus than to wait until metastatic extension and other complications have occurred, such as those reported by Dr. Scheer. Dr. Kopetsky in a recent monograph on the "Systemic Infections Complicating Middle Ear Disease" has called attention to a very well put point. He differentiates between the two types of mastoiditis, the coalescent type and the hemorrhagic type, where the bone cells are intact, and where there is a great deal of bleeding and not much bone destruction; and he brings out the point that this hemorrhagic type of mastoiditis is a sort of thrombotic process in all the tiny vessels and capillaries throughout the mastoid bone, and that it is in these cases we are more apt to get the septic complications than in the coalescent type. In one of Dr. Maybaum's cases, the child had various metastatic processes with a normal middle ear, and yet at operation very little was found in the mastoid, though there was a sinus thrombosis; that is explained better by the statement of a localized sinus thrombosis of these tiny capillaries than in any other way; and perhaps when we operate it would be well to note what type of mastoid is found when the mastoid process is opened.

DR. LEWALD said he had hoped to hear more about the X-ray findings in these cases. What Dr. Heller had just brought out was absolutely to the point, *i. e.*, in the type of sinus involvement where there is some destruction of the roof of the sinus, it would seem that the X-ray examination would have revealed that fact. It would have been as great a comfort to the operator as a positive blood culture. The converse is just as true, that some of these cases may have shown no bone destruction, and consequently a negative X-ray finding. But one would not have withheld operative procedure on that account.

DR. H. M. SCHEER cited a case similar to Dr. Heller's, which was seen after having been watched for a short time by the family physician. A young man of 25 years had been suddenly seized with an acute pain in his right ear, and two hours later the physician made a diagnosis of acute otitis media purulenta. When seen by Dr. Scheer, the patient had a temperature of 102° and a bulging red drum. A paracentesis was performed, and pus under pressnre was discharged from the middle ear. Twenty-four hours later the family physician notced that the right side of the face was entirely paralyzed, and Dr. Scheer was again called in. He saw a good opening in the drum, and confirmed the diagnosis of right-sided facial paralysis. There was no tenderness over the mastoid, and no other physical findings were elicited. The patient was watched for three days, thinking that the paralysis might be due to middle ear involvement, no signs of mastoid involvement having been seen. The middle ear process began to subside, and the temperature became normal, and after the fourth or fifth day the man felt perfectly comfortable, had no tenderness, and showed no signs of mastoid involvement. An X-ray examination by Dr. Law showed the mastoid to be negative. Dr. Maybaum saw the case in consultation, and advised waiting, that the mastoid should not be opened, and that the middle ear inflammation might possibly be the cause of the paralysis. At the end of another four days, another picture was taken by Dr. Law, as a comparative plate, and, as Dr. Law expressed it, he could barely make any differential diagnosis between that and the first plate. After waiting another week, another plate was made, and still Dr. Law could not tell that there was any involvement of the bone, but there seemed to be the slightest suspicion of bone absorption at the tip. The discharge from the ear became a bit more profuse and thicker; the temperature

was negative, there was no tenderness, and the patient felt very comfortable. The right-sided paralysis was still complete. It was then decided to do a mastoidectomy, and at the operation a large tip cell was found with some pus in it. The rest of the mastoid appeared unchanged. There was no exposure of the facial canal visible, and nothing else was found. After a thorough exenteration, the wound was closed in the usual way, and the man made an uneventful recovery. The facial paralysis began to clear up on the third day after the operation, and at the end of the third week the entire facial condition cleared up and the man was discharged well.

DR. S. ROSEN said that it would seem that the importance of blood cultures cannot be overestimated. The impression gained from the blood culture work at the hospital is that it is of inestimable value. It is true that diagnoses of sinus thrombosis were made almost as often before the days of blood culture, but undoubtedly, many were missed. The clinical picture should be the guiding influence; but one is apt to get into trouble if the help derived from blood cultures is neglected. A patient may present a clinical picture of sinus thrombosis and may have diffuse rales in the chest, so that it may be difficult to make a differential diagnosis between an otitic sepsis and pneumonia, excepting by blood culture, as in one of the cases presented tonight. Then the question of arthritis comes in. Certainly some cases of acute rheumatic fever present a typical clinical picture of sinus thrombosis with chills and fever, the temperature rises being 105° and 106° with joint involvement. It is important to determine whether the joints are metastatic, that is, involved by the ordinary cocci. In the true rheumatic cases, we have persistently negative blood cultures. The estimation of positive as well as negative blood cultures has certainly been a great aid in the interpretation of clinical symptoms and signs as well as pathogical findings.

SECTION ON LARYNGOLOGY AND RHINOLOGY.

January 28, 1925

Paper: "Nasal Tampon Treatment of Sinus Disease." Dr. J. Ivimey Dowling.

DISCUSSION.

DR. LLEWELLYN E. HETRICK took exception to the statement by Dr. Dowling that he inserted the tampons in the nose above the scroll of the middle turbinate; and said that his own custom had not been to do this, for there might be some anatomical difficulties in placing the tampon in exactly that situation. He has been in the habit of placing the tampon in the middle meatus beneath the middle turbinate and as close to the outer wall of the nose as possible. Owing to the great variation in the situation, size and shape of the middle turbinate, it is impossible sometimes to insert any but a very small tampon, and to get it in the middle meatus above the scroll of the middle turbinate seemed hardly possible. As to getting the tampon in approximation with the ostia, it is impossible, as long as the middle turbinate is in position, but we can get it very close in many cases.

Dr. Hetrick said he disagrees somewhat with Dr. Dowling in regard to the mechanism of the tampon treatment, for the doctor made it appear rather more complicated than it seemed to him. In his opinion the action of the tampon is due to a similar effect of a foreign body in the eye. There occurs during the placing of the tampon in the nose a profuse rhinorrhea, the excretions being greatly increased, and that increased flow if thin watery mucous which takes place during the time the tampon is in position is entirely due to the presence of the foreign body and it produces a definite irrigation. There is a secretion of a thin watery mucous from all parts of the mucous membrane and by means

of this increased secretion Nature flushes the sinuses from within out. Certain it is that following this treatment the patients all experience marked relief of the head congestion and, as Dr. Dowling said, their sensorium was clearer. There is hardly any class of disease that produces such a sense of depression as does sinus disease, and this mental depression is relieved almost magically by the tampons.

The question of the use of the X-ray in the diagnosis of sinus disease: Probably all would agree that it is only of value in those cases that are definitely positive. That an X-ray is negative does not mean that there is no sinus involvement.

The bleaching of the tampons in the presence of infection is quite characteristic and peculiar. Whether this is due to the colloidal silver, or whatever it may be, it will bleach over the area of the infected sinus.

Dr. Hetrick reiterated his belief in the value of argyrol. It is well known that hospital managers always try to use something that is just as good as argyrol and does not cost so much, but none of the other silver salts will do the work that argyrol does. He could not say too much in favor of this method of treatment, and closed by expressing the conviction that if Dr. Dowling, through his paper, had succeeded in so impressing its value upon the audience that a number of them would try it, he would have done a great service to all in presenting the subject.

Dr. Harold A. Foster said that about twenty-five years ago Dr. Dowling went to Albany where he began research work of sinusitis and complications. His principal discovery was that a colloid substance placed in the middle meatus and left there for a suitable length of time produced certain reactions. It seems as though the name of this procedure should be called "The Dowling Theory".

Before starting the discussion of Dr. Dowling's paper, I want to give what appears to be the answer to this theory. Due to their structure, formation and location, the ethmoid cells seem to be the vulnerable portion of the nares. They are prone to infection; they make a wonderful culture media and easily radiate their virus to the frontal, sphenoid and maxillary sinuses. The effect of argyrol placed and left in the middle meatus has not a direct effect on the various sinuses, but produces sterility to the ethmoid cells and inhibits the spread of infection. This allows the other sinuses, freed from the base of supply of infection, to tend to recover or to be more amenable to treatment.

A frontal sinus with its natural downward drainage is not given to infection unless there is cause at its outlet. Neither is a maxillary sinus without reason, either dental or nasal, prone to disease. In other words, render sterile the ethmoid cells so that the other sinuses may be clean.

There are so many instances where argyrol is indicated that it would be impossible to itemize them. One of the most obvious results from the use of the Dowling tamponade is in the treatment of polypi springing from a chronic ethmoiditis. The mucus membrane of the middle meatus and turbinates, due to the pressure from the polypi and continued bathing in pus, becomes hypertrophied, lifeless and degenerated. The nasal space is thereby lessened, increasing the difficulty of surgical removal and the turgescent engorged condition of the membrane causes, not infrequently, excessive hemorrhage upon surgical work. With a careful use of nasal argyrol tamponades the tissues' resistance can be greatly improved before surgical intervention. The membranes of the middle meatus and turbinates become shrunken, firm, and approach a normal appearance. The infected area of the ethmoids is cleared of pus and debris with the desired result that the operative field is rendered more sterile and the intranasal space considerably enlarged and the polypi now can be more easily removed with less chance of hemorrhage. Following the removal a course of argyrol tamponades are used to improve the infected tengescent tissues. The results, following the above method are gratifying and successful, and the remaining polypoid tissue tends to shrink up and the ethmoid cells return to a normal state.

Argyrol tamponades can be recommended and used with satisfactory results in postoperative nasal work. Following submucus resection with swollen turbinates and mucous membranes and excessive discharge of mucus we have a source of annoyance to patients and operator alike. This condition will be speedily overcome and improved with a few successive argyrol bakes. The argyrol tends to dry up the secretions, limit infections, harden the mucus membrane and bring the postoperative submucus speedily to the desired result. Likewise in postoperative turbinectomy and sinus work the argyrol seems to act specifically in reducing the congestion and rendering the field sterile and bringing the phase to a speedy and satisfactory conclusion.

In chronic catarrhal otitis media I have found that argyrol treatments will help materially in aiding and rendering less difficult inflations. The mucus membrane around the Eustachian orifice is reduced and infection is removed, thereby making inflation more successful with less chance of conveying trouble to the middle ear.

Argyrol is very important in the treatment of many acute and chronic nasal complications, but I am free to say that I have had very poor results in attempting to cure asthma by the argyrol tamponades.

In concluding may I assume that the Dowling theory is correct? It relieves and cures many congestions, and infections. By its actions it may render unnecessary surgical procedure on the sinuses, but I cannot attribute a great deal to its curative effects on asthma.

Dr. Harmon Smith said that upon a former occasion at one of the meetings of the section having as its subject the care and treatment of accessory sinus disease, Dr. Jonathan Wright had made the statement that when all nose specialists had exhausted every means by which the accessory sinuses could be evacuated surgically, they would ultimately conclude that the same results could be arrived at by intelligent and assiduous treatment. It would appear from the presentation of facts by the author of the paper that Dr. Wright's prophecy was approaching fulfillment. Dr. Smith lamented the absence of those who had persistently refused to accept any treatment for sinusitis as effective other than operative, but observed that they were probably in the class mentioned by the author as "sot in their ways". It might be concluded by those hearing the paper that a few only had followed this method of treatment, but owing to a coincidence he personally had profited by this method in having had a patient who had been cured by the author of the paper having passed through the surgical hands of three of the most ardent advocates of surgical procedure, before an endeavor on his and the author's part culminated in the cure of the case. Dr. Smith admitted that his means of treatment in this particular case were of little avail until the patient had fallen into the hands of the author, and only by following up this method was the patient finally restored to health. From this experience he had continued it in other instances, only varying it by first shrinking the tissues, sucking out the sinuses by means of his sinus suction syringe, which also leaves the medication in the sinuses, and, lastly, placing the tampon *in situ* and leaving it there until the patient reached his business or returned home or for one-half to one hour. Dr. Smith also said that instead of argyrol, which was not aesthetic and very disagreeable to use, he had employed other colloids of silver, as collene, etc.

If operation were a *sine qua non* and the result could be guaranteed beyond peradventure, the quickest way would be to go head and operate, but it did not always succeed. Hardly a week passed that he did not see cases that had been operated upon—and successfully as far as the operation was concerned—where the sinusitis had recurred, and it took as long to cure them afterwards as if they had not been operated upon. The trouble was that most specialists were too busy to give the patient the time required. The medication was not left in place long enough to obtain the full benefit thereof. It was impossible, in a large practice, to have a number of patients waiting around with tampons in place for

from ten minutes to an hour to reduce this turgescence. It took always longer than ten minutes to accomplish what was intended by the depleting effect of colloids of silver.

Dr. Smith said his method had been to put the tampon in and leave it so that the patients could extract it, and allow them to go home and remove it after about an hour. Treating a case every other day, or twice a week, or once a week, was of no avail. To treat a sinus case successfully, it should be treated once a day, in the majority of instances —in the beginning at least—and then one would begin to get results. Not until one took the time to treat these patients properly, and try to do something other than operate, would we change the opinions of those who think that nothing is worth while but operation.

Dr. Freudenthal said that it was a rather peculiar coincidence that he had used a very similar treatment ever since he can remember. Probably all present knew of old Dr. Gottstein's treatment for ozena and similar affections. This he had applied to atrophic conditions in the nose. He regretted that he had not read any of Dr. Dowling's publications, but neither had the doctor read any of his. About six or seven years ago he had read a paper before the Eastern Section of the Trilogical Society on a new form of treatment on the nose and throat, and at that time mentioned these applications. He had made certain experiments along these lines. When a tampon is put in the nose, if there is any degree of normal physiological action there the medicine is absorbed in a short time after the tampon is inserted; whereas in atrophic conditions half an hour or more is required for the medicine to be absorbed. Even then absorption does not always take place.

He agreed with Dr. Dowling in regard to avoiding the use of cocain in these cases. Usually he employs other measures in addition; in a case of empyema of the antrum, for example, he first washes out the antrum, for this reason: after syringing the edematous condition of the inferior turbinal is sometimes lessened very much, temporarily, and the tampon can be put in as far as desired. These tampons are left in for quite a while, and there is often quite a quantity of pus, scabs, etc., removed afterward. In his opinion, this is a sign of the capillary attraction to which Dr. Dowling had alluded, but in many cases it is not more than what Dr. Hetrick alluded to as the presence of a foreign body, or the production of Bier's hyperemia. The coating over the mucous membrane is gone, the celia begin to act and Nature begins to assert herself. He does not always use 10 per cent argyrol, but often uses boric acid, ichthyol, and argyrol in varying strength, 2, 5, 10 and even 15 per cent in some cases. He never closes both sides of the nose, for in many cases that would produce too much reaction. He had not given up the old methods entirely, for certain cases have to be operated upon, but we have to try other methods, and often get better results than by operating.

Dr. Freudenthal said he has had a somewhat large experience with asthma, and had seen some remarkable cures. He recalled the case of an old lady with catarrhal trouble whom he had treated with iodin, glycerin, etc., and who in his absence went to his assistant and told him that she wanted him to use the red medicine. He replied that he did not know what the red medicine was. "What," she retorted, "you have not got it; what sort of a specialist are you?" It is the same with asthma. One may sometimes get wonderful cures with very simple remedies, salt, soda, etc. These cases are remarkable, but they are purely psychic and the patients will come again for treatment.

He agreed with Dr. Dowling, that the internist and the rhinologist should work together in the treatment of these cases.

Dr. Delavan said that when he first began the study of the nasal sinuses they were known mainly as anatomical entities. Since that time, much has been learned of their pathology and many methods of treatment have been described. Many of the advances have been made through the efforts of American contributors. The surgical treatment of the sinuses, formerly in the hands of a few operators of exceptional skill, is now extensively practiced.

He heartily endorsed the views expressed by Dr. Harmon Smith and with him welcomed a principle of treatment which promised some relief from the excessive resort to radical measures which of late years had been so readily and sometimes so ruthlessly employed. In some cases radical measures are undoubtedly desirable, but it must be admitted they have been employed with great frequency, sometimes unnecessarily and with unsatisfactory results; while in the case of the radical frontal operation the resulting disfigurement has blemish. Such operations should be undertaken with hesitation unless clearly indicated. Any method which promises to relieve the necessity of radical surgical measures deserves most earnest attention.

Dr. Delavan said he had been greatly interested in the ideas advanced in the paper of the evening. The subject was too broad to be discussed casually, nor had he the practical experience with it necessary to do it justice, but he welcomed it and hoped that it would be carefully studied and tested, and that the results would show a great advance in the treatment of these cases.

Dr. R. C. Eckardt said that his acquaintance with Dr. Dowling began about fifteen years ago, and that he felt he could speak on this subject from a somewhat different point of view, for he had himself been a patient of Dr. Dowling's. Since then he had practiced this method on his patients. Sometimes, in the cases where there is not room to use a large tampon, the small tampons are very effective. One does not always have to place it high above the middle turbinate; in most cases he places it beneath. He has found that the number of cases requiring operation is materially reduced by using this method of treatment, as advocated by Dr. Dowling. Cases that looked as though they would have to be operated upon have cleared up completely after a few treatments. The use of these tampons is the most valuable single addition to our armamentarium that he knows of.

Dr. Heller said he would like to have Dr. Dowling state definitely whether he meant the superior or the middle meatus, for if the tampon was put in the superior meatus it was difficult to see how it could affect the maxillary sinuses, etc. Second: was he trying to exert pressure, or did he depend entirely on the medication of the argyrol. Third: if one is going to get any effect with argyrol, it must be fresh; it will not keep more than eight or ten days. Also, inasmuch as so much emphasis was placed on the value of this treatment in young children, how does he manage it? Dr. Heller said that he has found it very difficult to apply such a treatment to a young child the second or third time. He can get away with it the first time, but after that it usually takes several adults to control the child, and if Dr. Dowling could tell how to do it he would be very grateful. He also wished to know whether any home treatment was instituted.

Dr. Michaelis asked what Dr. Dowling meant when he said that the tampon was itself a diagnostic aid in the determination of sinus disease more certain even than the X-ray. While he himself held no brief for the infallibility of the X-ray in the diagnosis of sinus disease he could not see how a mere tampon in the nose could effect such an infallible diagnosis.

Dr. Dowling, in closing the discussion, said he would try to answer the various questions, but could not do so exhaustively for it would occupy as much time as the reading of the paper.

As to glycerin and ichthyol, that was one of the first things that he had used in the attempt to determine what virtue there was in any kind of medicine applied to the nasal tissues by means of the tampon. That went back twenty-five years, but other men may have had quite similar findings without having read papers by others. It was very gratifying to find that Dr. Freudenthal's work corroborated his own. The first preparation used was one of ichthyol, glycerin, and other ingredients called "ichtholdin". He had had some experience with it in gynecological work, and noticed that it occasioned very considerable depletion of the tissues and therefore believed it would prove beneficial in treating the sinuses, which proved true.

Dr. Dowling said he agreed with Dr. Smith that in the average case one should give daily treatments if possible. As for the home treatment, sometimes he prescribes a salin solution for irrigation, or a mentholated ointment, etc., but not when they can be seen frequently. Some of these patients live in the Adirondacks, and daily visits are impracticable.

As for the diagnostic value of radiograms, Dr. Dowling said he did not take issue with anyone concerning their value but often radiograms simply indicate the size of the cavities and the report is negative, very correctly; but it is in just that type of case that the tampon placed in the middle meatus gives relief. If in reading the paper he had said "superior" meatus, it was an error in speaking.

In referring to eye diseases of uncertain origin the doctor stated that argyrol tampons could be used for diagnostic purpose to determine any possible complication involving the sinuses. If, upon withdrawing the tampons they were found to be decolorized, he considered that sufficient evidence of later infection of the sinuses and despite negative report of radiograms he considered that such eye diseases should receive the benefit of complimentary nasal tampon treatment. In the presence of serious progressive disease of the uveal track or of the optic nerve he believed that the diagnostic value of argyrol tampons was such as to warrant operation upon the ethmoid cells and sphenoid sinuses, even in the face of negative radiograms.

Dr. Dowling further stated that he believes the time will come when the lack of operative procedure upon the posterior ethmoid cells and sphenoid sinuses will be considered an error of judgment on the part of the oculist treating these cases, and that many of the younger men would live to see the day when oculists will always refer such cases to the rhinologist for opinion and possible operation, during the early stage of so-called progressive optic nerve atrophy.

Replying to the suggestion of one of the speakers that the tampon acts as a foreign body in the eye, Dr. Dowling said that the ocular effects associated with nasal tampons are induced by stimulation of the collateral circulation.

The doctor stated that the application of drugs in colloidal solution to mucous membranes possessed many virtues over other methods. His ideas concerning the use of colloidal preparations had been influenced through discussions with such eminent authorities as Willis G. Whitney, of the General Electric Co., and Hille, who had invented argyrol. He believed that although the teachings of Martin H. Fischer, Loeb, and others relative to colloidal pathology was now little considered, that the time would come when they would be considered leaders in thought who were in advance of the times.

Concerning the strength of solution, the doctor determined that a 10 per cent solution was best adapted to this treatment for the reason that it is a near approximation in specific gravity to that of the mucous discharges as ascertained by tests made by competent chemists.

As for what had been said about asthma, Dr. Dowling said he hoped that would rest in the minds of those who heard him and excite some thought. He made no claim to cure asthma. If patients voluntarily stated that they had experienced cessation of attacks over a lengthy period the doctor accepted this as the patient's belief that they were cured and in the absence of organic lesions in vital organs he classed these cases as "cured". He was surprised himself to note the number of patients who had reported satisfactory relief from asthma after a course of nasal tampon treatment.

The great point is how to treat the ethmoid pathology and tamponage is one way of doing it. It is not claimed that this is the only method, but that this is one with which all rhinologists should be familiar in addition to other measures, such as suction and irrigation which are so generally used.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY.

Meeting of Feb. 13, 1925.

DR. J. S. MACNIE, *President.*

Congenital Narrowing of the Esophagus. Dr. Kenneth A. Phelps.

Baby R., age 7 weeks, was referred to me by Dr. E. D. Anderson, because of choking and cyanosis, which occurred at each feeding. There seemed to be an unusual amount of mucus in the baby's throat, which at times, necessitated removal by means of a catheter and suction.

The previous history is as follows: At two weeks of age the baby vomited its food. The vomiting was projectile in character, and occurred after one or two feedings a day. This became worse and at three-and-one-half weeks, the baby vomited nearly everything. She lost weight rapidly. She was then taken to the hospital and fed breast milk, per tube. Tubing was difficult and seemed to make her vomiting worse than ever. Atropin in large doses produced no improvement. X-ray showed 90 per cent of the gastric contents passed through the pylorus at the end of four hours. The diet was then changed to thick cereal, and she could keep this down; though it took nearly an hour for her to take 2 ounces. Water made her vomit at once. Hypodermoclysis was given daily, to keep up the fluid intake.

At seven weeks, she began to have choking attacks and cyanosis, which was much worse during feedings. X-rays were again taken, which showed definite stenosis of the lower fourth of the esophagus, with considerable dilatation above.

The esophagus was dilated by the Plummer method and the baby immediately improved. She was able to take liquids, so hypodermoclysis was discontinued. She gained weight at once and progressed to a complete recovery in three weeks.

She can now swallow as well as her twin sister. X-ray shows no obstruction in the esophagus.

Congenital anomalies of the esophagus are rare and the type this case illustrated is particularly uncommon. Such anomalies are classified as follows:

A. Absence of entire esophagus.
B. Esophagus represented by a solid cord throughout.
C. Doubling of the esophagus.
  (1) Complete.
  (2) Partial bifurcations joining near the lower end.
D. Congenital dilatation.
E. Congenital diverticula.
F. Atresia.
  (1) Upper cul de sac.
    (a) connected to stomach by solid cord.
    (b) no connection to stomach.
  (2) Two parts to the esophagus.
    (a) Upper blind sac.
      (1) Lower opening above into trachea or bronchus and below into stomach.
      (2) The blind sacs connected by solid cord.
      (3) The blind sacs not connected.
G. Tracheo-esophageal fistula with trachea and esophagus otherwise normal.
H. Stenosis—upper or lower part—never in middle.
  (1) Caused by a fold in mucous membrane.
  (2) Caused by diaphragm.
  (3) Narrowing of lumen—involving entire wall.

Congenital Occlusion of the Choanae. Dr. Kenneth A. Phelps.

Dorothy A., age 4 months, referred by Dr. Martin Nordland. The baby was born two-an-one-half weeks prematurely, the labor being long, forceps were used. She was a blue baby and breathing was started with some difficulty, the usual methods being unsuccessful; however, when her mouth was held open forcibly, she began to breathe. A nurse was kept in constant attendance to hold open her mouth, for it was found that as soon as it closed cyanosis appeared and breathing ceased. Respirations, with the mouth open, were very noisy, the tongue seemed to cleave to the roof of the mouth continuously.

Nursing from the first was impossible, as the baby could not breathe and nurse at the same time, so the child has been fed through a stomach tube since birth.

After the eighth day, she seemed to have learned how to hold her own mouth open to breathe. She had many attacks of cyanosis but would finally open her mouth to breathe if left alone.

There was an abundant yellow discharge from both nostrils, which poured out when the baby was tipped face down.

The voice has been clear since birth. The chest, on physical examination and X-ray, is negative, no thymus gland enlargement showed in the film. A very small mass of adenoids could be felt in the nasopharynx. The posterior nares were both completely occluded by a bony-like obstruction. A probe could not be passed through either nostril.

With the soft palate retracted, a Holmes nasopharyngoscope was used and the choanal occlusion could be seen. On the right side it seemed to be dimpled and on the left solid. Trying to blow air through the nostrils with a Politzer bag made tears bubble at the lower punctum of the lids. No palate, septal, jaw, or facial deformity could be discovered.

Operation: The left posterior nares was opened by means of a chisel, for it seemed to be solid bone. The right side was easier to open. Both were rasped well with a frontal sinus rasp and the new opening curetted. The posterior end of the septum was removed in one piece with its attached membrane on each side, by means of a forcep through the mouth. No tubes or packs were left in the nose.

There was little reaction from the operation and no improvement in the breathing for two days. I then placed a silver Eustachian catheter through each nostril, well into the nasopharynx and held the mouth closed, and for the first time the baby breathed through her nose. From this time on she was able to take the bottle and the stomach tube feedings were discontinued. During the next two weeks her breathing improved and she slept with her mouth closed. She left the city for a month, during which time both sides closed with granulations. Upon her return these were rasped away and she again breathed through her nose.

The yellow discharge has largely disappeared. Probably the opening is not yet permanent and more treatment may be needed to maintain good function.

A Series of Cases of Simple Mastoidectomy. Dr. J. A. Pratt.

The after-treatment of simple mastoidectomy depends on the type of infection, the method of operating, complications encountered and the reaction of the patient. In order to open this discussion, I will describe the method we have used for the past twenty years.

In preparing the female patient we do not cut the hair or shave the scalp, but plaster the hair down with non-flexible collodion, which keeps the hair in place until the wound is healed.

We do an electric burr operation for the following reasons: shortness of time of operation, thoroughness of opening the cells, no concussion shock, less danger of sinus and nerve injury, and with a small opening and smooth cavity, there is a quicker healing with less deformity. We try to keep the bone opening about 10 m.m. wide and running from the antrum to the tip. After the operation, unless the sinus is opened, a

spiral-cut rubber tube enclosing a gauze wick is placed in the cavity, starting in the antrum and coming out at the tip. The wound is now closed with Michel clips down to the rubber tube and after the gauze is placed in the external canal, the bandage is applied. If the case is a small child and the adenoids are large, they are removed at this time.

As soon as the temperature is normal the patient is allowed to go home, which as a rule is the following evening. The first dressing on the third day following the operation is usually made at the office. The clips are removed, the gauze removed from the drainage tube and not replaced, but the gauze is replaced in the external canal. The ear is covered with cotton and all is covered with the triangular-shaped black bandage. (Shown.)

The wound is now treated every day by drying out the drainage tube with swabs of cotton. On the fifth or sixth day the tube is removed and the cavity is irrigated with a potassium permanganate solution. After thoroughly drying the cavity with cotton swabs, the tube is returned to its former position. Each day thereafter the tube is removed and cleaned and all discharge removed with cotton swabs. Some time between the tenth and fourteenth day the tube is removed and the opening allowed to heal. If there is any discomfort, the opening is kept patulous by passing a small cotton wound applicator down to the antrum. This is rarely found necessary.

Our simple mastoidectomies are usually healed in twenty-one days. By using the spiral-cut tube only, there is generally a blood clot formed, which shortens the healing time.

Case 1: This patient, Mr. M., was the cause of the presentation of this paper. He was operated upon for acute mastoiditis in Michigan twenty years ago. He says the wound was packed for nine weeks and he was then discharged with a small hole back of the ear. The examination showed a scarred mastoid, very little depression, a small opening about 4 m.m. in diameter. This lead into a cavity filled with cholesteatoma, which, on removal, left a dermatized cavity about 2 c.m. in diameter. The left ear was also discharging and there was communication between into the mastoid cavity. This is a case of over-zealous packing.

Case 2: Dr. C., mastoid operated some years ago. After-treatment, mastoid packing. Operation successful, but left a depressing scar.

Case 3: Mr. N., operated two years ago. Patient had acute mastoiditis for six weeks. Left the hospital the day following the operation. Was well in two weeks. The after-treatment used was what we have described.

Case 4: Mrs. R., acute mastoiditis, left ear running four weeks before operation. Was operated Jan. 3. Patient was very septic, temperature second day, 104.° Patient left hospital on fifth day. Case healed in seventeen days. After-treatment the same as described.

Case 5: Miss R., acute mastoiditis, following scarlet fever. Ear started discharging while still sick with scarlet fever. Operated Jan. 23, after six weeks of middle ear suppuration. Left hospital the fifth day. At time of operation, the urine showed a plus 3 albumin; two days later, just traces. Case was well in seventeen days. After-treatment as described.

Hereditary Hemorrhagic Telangiectasis. Dr. Virgil Schwartz.

L. W., housewife, age 49 years, was admitted to the hospital Dec. 4, 1924, with severe epistaxis. She had been troubled in this way innumerable times since she was 14 years of age. Also she had had severe hemorrhages from tip of the tongue and from the tip of her right little finger on several occasions. She has been aware of a number of reddish spots on her face, tongue and hands for many years. She had a submucous resection five years ago, somewhere, and a perforated septum resulted. Two years ago there was a nasal hemorrhage so severe as to require hospitalization. A week prior to her recent admission she had had another such attack.

She has three children living and well. The father died of heart trouble; while an item of great importance is the fact that her mother died as the result of frequent, almost uncontrollable, nasal hemorrhages. Three brothers are well, and her sister died in infancy of diphtheria.

Except for evidence of a definite anemia secondary to her epistaxis, her laboratory studies show nothing abnormal. The coagulation time is five minutes, while the bleeding time is two-and-one-half minutes.

By firm tamponade the patient's epistaxis was held in check for a day or two at a time, but shortly after the removal of each pack the epistaxis recurred. The process, therefore, had to be repeated a number of times before it was possible to attempt cauterization. However, this was finally begun and has been continued with success, being directed principally at the margin of the perforation and the septal surface immediately adjacent to this.

The case was transferred to the Medical Service, and there attention was drawn to the fact that the patient has a number of dark or bright red spots of from 1 to 4 m.m. in diameter scattered over the body surfaces, both skin and mucous. Most of these are rounded and are present on the dorsum and tip of the tongue, the lips, the hard and soft palate, the nasal mucosa, the conjunctivae, the auricles, the cheeks, the hands and fingers, and one or two on the trunk. They greatly resemble petechiae, but differ markedly in that the latter are temporary, being only small bloody effusions, while the lesions here present are greatly engorged, swollen capillaries and venules—in other words, telangiectases.

It would be of great importance to know if the patient's mother, who died as the result of epistaxis, also showed these vascular anomalies. I believe that she did, though of course we have no proof beyond the history. If such were the case, it would add another family to a very small group, for up to 1923 there had not been more than thirty reported families, involving fifty-seven patients, who exhibited this hereditary hemorrhagic telangiectasis. Even if there were no such lesions in the preceding generation, it still remains a rare affection.

Ample precedent exists for the study of this condition in rhino-laryngology, for Chiari was one of the very first to recognize these lesions as telangiectases in a case of epistaxis, though he regarded them as caused by or associated with hemophilia. As a matter of fact they have no relation to hemophilia, purpura, acquired angiomas, or the hemorrhagic diathesis.

I wish only to mention very briefly the principal features of hereditary telangiectasis as recapitulated by Weber in 1908 and Steiner in 1917. The only constant etilogic factor is heredity; both sexes are involved about equally and may transmit the disease in the same degree. It is congenital, and is characterized by a developmental defect in the walls of the idlated capillaries. These latter lie immediately beneath the markedly thinned epidermis or epithelium. They are simply large blood-spaces lined only with a single layer of endothelium, and their walls seem to have no elastic nor muscle fibres. This structure predisposes to easy rupture, either traumatic or spontaneous, and so to hemorrhage of small or great degree. This occurs most frequently from the nose, usually long before the individual lesions appear, which may not be until middle life, and less often from the tongue and fingers, as in our case. Unfortunately the hemorrhages and the subsequent anemia seem to increase in frequency and severity with age, but by the thorough use of the cautery, preferably the chromic acid bead, and possibly radium, great improvement, if not complete cure, may be brought about.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY.

February 10, 1925.

The Nashville Academy of Ophthalmology and Oto-Laryngology met Jan. 19, 1925. The Chairman, Dr. Robert Sullivan, presided and the following cases were discussed.

Lynch Frontal Sinus Operation. Dr. M. M. Cullom.

Dr. Cullom showed the case of Miss C. W., age 55 years, who consulted him two years ago, complaining of deafness and a chronic purulent discharge from each ear, the ears having discharged since childhood.

Transillumination showed the left antrum dark; all other sinuses clear. A diagnosis of empyema of the left antrum was made and was confirmed by X-ray pictures.

A resection of the left nasoantral wall was done and a large amount of pus evacuated. The irrigations were kept up at intervals for about two months and the antrum cleared up, the purulent aural discharge subsided, and the hearing considerably improved. She was seen from time to time and the washings from the antrum continued clear.

Two months ago the patient returned complaining of headache. Transillumination showed nothing beyond cloudiness of the left antrum, the washings from which came away clear. The patient was seen at intervals for ten days, still complaining of headaches, which increased in severity and which were throbbing in character over the left eye.

Examination disclosed a tumor in the roof of the left orbit which was rather soft and had the feeling of a cyst. In a certain position a pulsation could be elicited. An X-ray picture was made which showed an involvement of the right frontal sinus, but a rather puzzling picture on the left. There appeared to be no cloudiness but an apparent loss of substance in the superior orbital ridge. Being anxious to know whether or not I was dealing with an aneurysm or an abscess, I aspirated with a hypodermic needle and drew off pus. Following the aspiration, infection took place in the orbital tissues and considerable swelling developed. Incision was made along the track of the needle puncture and pus was drained through the incision until the orbital cellulitis disappeared. Then the ethmoid cells on the left side were exenterated and an intranasal opening was made into the frontal sinus. Profuse drainage followed the intranasal opening. All the orbital swelling around the sinus disappeared and the sinus closed.

Jan. 5, 1925, the Lynch frontal sinus operation was performed. A Killian incision was made. A profuse discharge of pus followed the incision and it was found that practically the entire floor of the sinus had disappeared from the necrosis. The large sinus was filled with pus and granulation in spite of the fact that there was a free opening into the nose which had been kept open with a large frontal sinus probe every day. I think this illustrates well the futility of the hope that an intranasal operation can cure a well established chronic empyema of the frontal sinus. The cause of the pulsation in the orbital tumor was found to be that there was a large defect in the posterior wall of the sinus, exposing an area of the dura about as large as a silver quarter. The remains of the floor of the sinus were removed and the mucous membrane of the cavity curetted away. This region was packed with gauze soaked in iodin while the ethmoid region was being thoroughly cleaned out. A half inch drainage tube was inserted through the nose into the sinus and the external incision was closed without drainage. The deep structures were approximated with catgut and the skin was closed with skin clips. A large probe was passed through the drainage tube daily

and the tube was removed on the sixth day. Since that time a large frontal sinus probe has been passed into the sinus daily.

The points of interest in this case are: the fact that pus was never discovered in the nasal cavities, that no cloudiness was shown by transillumination, and that the X-ray picture was misleading.

DISCUSSION.

DR. HERSCHEL EZELL: To me the most impressive feature of this case is the fact that it occurred in an elderly person, as we expect to see this type of complication only in younger people.

DR. E. B. CAYCE: I think you can be very easily mislead by X-rays. I want to throw this out as a warning, as I learned it from a case in which the X-rays were absolutely negative, but when the frontal sinus was opened it was found to be full of pus. I think the success of a frontal operation depends upon two things; *i. e.*, the removal of the pathology and the establishment of permanent drainage and aeration.

DR. W. G. KENNON: Has there been any diplopia or any tearing of the sac?

DR. CULLOM (closing): I did not operate on the other frontal sinus. I had expected to find a communication between the two, but a very careful search failed to reveal any such communication. I did not feel justified in going through into the other side without more definite signs of trouble. In the four cases in which I have done the Lynch operation, there has not been the slightest muscle imbalance, nor any tearing. Three of the cases I have been able to follow very closely and the result is apparently perfect.

Stenosis of the Larynx. Dr. E. L. Roberts.

Dr. Roberts presented the following case: A. B., white, male, age 4½ years. Family history negative. The patient had simple croup several times. About the middle of November, 1924, he contracted diphtheria. Three days later his family physician was hastily summoned and found the child's condition such that an immediate tracheotomy was deemed necessary and was done without anesthesia. The patient apparently got along well and after twelve days the tube was removed. It was soon discovered, however, that he was not breathing well and in an hour or so the tube had to be replaced. During the following three weeks several unsuccessful efforts were made to get the child to breathe without the tube. The last attempt resulted in the child's condition becoming so serious that it was necessary to resort to artificial respiration for several minutes.

This patient was brought before the Nashville Academy of Ophthalmology and Oto-Laryngology at the December, 1924, meeting. At that time the possibility of a foreign body in the wind pipe was suggested. Attention was called to the fact that the larynx had been cut into and the tube placed in the larynx instead of below the larynx. The possibility of a psychic element was also mentioned and it was advised that the tube be gradually closed until the patient should become willing to make an effort to breathe normally. Intubation was also suggested, allowing the tracheal opening to heal by granulation.

Following this a bronchoscopy was done by Dr. Herschel Ezell but no foreign body was found, the condition being one of absolute closure of the larynx. On inspection of the stenosed area there seemed to be overlapping in the neighborhood of the cricoid cartilage, with considerable swelling and inflammation. Beyond this nothing could be seen. The vocal cords were visible above. Intubation was then attempted, without marked success, the family physician recently reporting that the child objected seriously to the presence of the tube. Efforts have been made from time to time to remove the tracheotomy tube, both with the intubation tube in, and without it. Either way, sooner or later the child begins to choke up and the tube has to be replaced in the trachea. The child talks better, however, than previously.

DISCUSSION.

DR. W. G. KENNON: In my opinion it would be a good plan to do a low tracheotomy and then try to splint the larynx in some way. It seems to me you ought to get rid of that continued source of irritation at the site of the original wound. If you do not get rid of that the chances of getting a good result will be practically *nil*.

DR. ROBERT SULLIVAN: I think the objection to wearing the tube can be overcome by making a small opening in the intubation tube, putting a string through that hole and as the tube goes down, pull the string out through the opening in the trachea and fasten the string with adhesive plaster. The tube will then stay in, as there is no way for it to get out. Then allow the lower opening in the trachea to close by granulation. Use a tube large enough to act as a splint and to hold this open until it grows back in the right position, then take the tube out.

DR. E. L. ROBERTS: I want to thank you for the suggestions that have been made. The idea of a lower tracheotomy appeals to me as being one of the best.

Atresia of the Pharynx Dr. W. B. Lee.

Dr. Lee presented V. B., a white female, age 15 years. This patient was referred to Dr. Lee by her family physician, who stated that she had come under his observation some three years ago with cough, ulceration of the pharynx, destruction of the soft palate, and apparent involvement of the right lung. A diagnosis of tuberculosis and lues was made and specific treatment instituted. About one year ago the patient developed an abscess of the middle ear, at which time she was referred to Dr. Lee, who treated the ear condition. Shortly after this the family physician left the city and on his return found that the ulcers in the pharynx had healed, but that the posterior nares were closed, rendering nasal breathing impossible.

DISCUSSION.

DR. M. M. CULLOM: I have seen a number of these cases and have seen all sorts of things done to try to get an opening, but I have never seen a successful one. They are very discouraging cases to attempt to do anything for, because of the scar tissue. This has been my experience. So far as relieving the condition, I think it is going to be a pretty difficult case to handle.

DR. E. L. ROBERTS: This is the first case of the kind I have seen, although it is not the first time I have seen this case. I saw her first about four or five years ago when making an examination of school children, and I saw her again about a year later. She seems to be a great deal worse now than she was when I first saw her. The soft palate seems to be pushed higher up and I do not believe there was complete closure the first time I saw her. My opinion then was that the trouble was of specific origin. While, as Dr. Cullom suggests, these conditions are difficult to handle and rarely successful, yet if there is any possibility at all of giving this patient even slight nasal breathing, I would make the effort.

DR. EUGENE ORR: I have seen three cases of almost complete tresia of the pharynx, all the result of adenoid operations. I cannot say as to the results as I did not have the opportunity of following them up. One of these cases had been operated on previously and the operating surgeon stated that the child had about twice as much breathing space as he had before the first operation. The operation which was done was simply an incision through the mucous membrane, and the posterior wall of the cut membrane was turned up and twisted so that it became anterior and was brought up against the posterior wall of the soft palate and wired with silver wire.

DR. ROBERT SULLIVAN: I operated on a case in which there was complete atresia following a tonsil and adenoid operation by a general surgeon. After dissecting out everything that I thought was scar tissue, I used an ordinary rubber catheter, pulling it out through the nose tight

enough to keep the soft palate from adhering to the posterior pharyngeal wall. The patient has some breathing space following this operation. Inasmuch as the this case was traumatic, I believe the chances for improvement were better than in Dr. Lee's case.

April 8, 1925.

The Nashville Academy of Ophthalmology and Oto-Laryngology met at St. Thomas Hospital, March 16, 1925, with the Chairman, Dr. Robert Sullivan, presiding. Dr. Herschel Ezell presented the following case:

Otitis Externa Hemorrhagic. Dr. Herschel Ezell.

L. L., a white female, age 12 years, first consulted me March 14, 1925. She gave a history of having had grip for several days previously and pain in the ears of twenty-four hours duration.

On examination the patient's hearing was impaired, she being able to hear loud voice only. In each external auditory canal, on the inferior wall, was found a large elongated tumefaction resembling a blood blister. The tumefaction in the left ear was oozing slightly, while the one in the right ear was dry, movable, and changed shape when the auricle was pulled upon. The provisional diagnosis was bilateral suppurative otitis media complicated with hematomata.

Under nitrous oxide gas the tumefactions were opened. A small amount of bloody serum was drained from each. On account of the hematomata, no view of the drums could be had.

A very interesting observation in the case is that the hematomata that was draining previous to operation has not discharged much, while the opposite ear is running a typical course of acute suppurative otitis media.

From the behavior of the case the condition is strongly suggestive of otitis externa hemorrhagica.

The right ear is discharging more than formerly, but the blood tumor is still present.

The existence of this condition as a separate entity is questioned by some otologists. Few writers, it seems, mention the condition. Bacon has reported several cases in which such effusions of blood have occurred independent of middle ear inflammation. (Archives of Otology, Vol. XIX, No. 1.)

DISCUSSION.

DR. W. G. KENNON: Some two or three years ago, Ballenger, I believe, wrote an article on these hemorrhagic types of otitis media that were quite common in certain camps during the influenza epidemic. He described very much the same condition that Dr. Ezell's patient shows. I have never seen one with quite so marked a bleb, it is interesting from that standpoint. In many of the cases Ballenger did a myringotomy at the beginning before the blebs had formed. In some of the cases these blebs formed subsequent to the myringotomy.

DR. EZELL (closing): I may add that the blebs, especially the one on the right side, filled the canal, which was quite red. As the auricle was moved the bleb could be seen. Now, of course, the blebs are very much reduced in size.